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BENGALURU
CITY UNIVERSITY

Office of the Registrar, Central College Campus, Dr. B.R. Ambedkar Veedhi, Bengaluru – 560 001.
PhNo.080-22131385, E-mail: registrarbcu@gmail.com

No.BCU/BoS/Syllabus-PG/Science/ 332 /2025-26 Date: 23.09.2025

NOTIFICATION

Sub: Syllabus for the Post Graduate Courses in the Faculty of Science– reg

Ref: 1. Recommendations of the Boards of Studies in the Faculty of Science
2. Academic Council resolution No.04 dated.22.09.2025
3. Orders of Vice-Chancellor dated. 23.09.2025

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The Academic Council in its meeting held on 22.09.2025 has approved the syllabus prepared by different Board of Studies for the Post Graduate Courses in the Faculty of Science. Accordingly, the following CBCS Syllabus for the Semester PG Courses of Science Faculty are hereby notified for implementation effective from the academic year 2025-26.

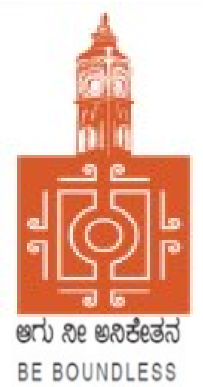
Sl. No.	Programmes
1.	M.Sc. Chemistry – I & II Semester
2.	M.Sc. Biochemistry – I to IV Semester
3.	M.Sc. Physics – I & II Semester
4.	M.Sc. Mathematics – I to IV Semester
5.	M.Sc. Psychology– I to IV Semester
6.	M.Sc. Counselling Psychology – I to IV Semester
7.	M.Sc. Fashion & Apparel Design – I to IV Semester
8.	M.Sc. Zoology – I & II Semester
9.	M.Sc. Botany – I to IV Semester
10.	M.Sc. Computer Science – I & II Semester
11.	M.Sc. Speech Language Pathology – I to IV Semester
12.	Master of Computer Applications – I & II Semester

The detailed Syllabi for above subjects are notified in the University Website: www.bcu.ac.in for information of the concerned.

REGISTRAR

Copy to;

1. The Registrar(Evaluation), Bengaluru City University
2. The Dean, Faculty of Science, BCU.
3. The Principals of the concerned affiliated Colleges of BCU- through email.
4. The P.S. to Vice-Chancellor/Registrar/Registrar (Evaluation), BCU.
5. Office copy / Guard file / University Website: www.bcu.ac.in



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Syllabus for Post Graduate
Botany

2025-26 onwards

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M.Sc., BOTANY [POST-GRADUATE] CHOICE BASED CREDIT SYSTEM (CBCS) SYLLABUS WITH SCHEME OF EXAMINATIONS

CORE SUBJECT: BOTANY; DEGREE: M.Sc., BOTANY (2025-26)

PREAMBLE

As per the guidelines of UGC and Higher Education Council, Government of Karnataka, the Board of Studies in Botany, Bengaluru City University (BCU) has adapted and framed the new syllabus according to the regulations governing the existing choice-based credit system (CBCS) for two-years (four semester) M. Sc., Botany (Post-Graduate) degree program.

Accordingly, now syllabus has been framed and approved from the academic year 2025-26. The M. Sc. program in Botany under CBCS scheme has a total of 100 credits consisting of hard-core courses with 84 credits, soft core with courses 12 credits and 4 credits for open elective courses. A provision has been made for interested students to undertake a Project Work of 8 credits. Those who are not interested they can study two soft core courses of credits. In this revised syllabus, more than new 10 distinct areas have been incorporated across 15 courses.

In total, 35% of the old basic concepts in the syllabus has been retained and nearly 45% of the syllabus is with new with concepts has been incorporated in both the hardcore and soft-core courses. When compared to previous existing syllabus, 15% of the syllabus comprises entirely new areas related to plant stress physiology, methods in biology, developmental biology, aquaculture, molecular biology and genome editing.

PROGRAM OUTCOME

- To provide the students a more inclusive and comprehensive curriculum in M.Sc., Botany program that integrates foundational as well as advanced concepts, fostering excellence in Plant Science.
- Preparing students with theoretical and skill competencies in areas of plant diversity, plant taxonomy, ecology, biodiversity assessment, conservation, molecular biology, biotechnology, herbal drug technology and genome editing etc.
- The program will equip the students with essential soft skills, transferable skills and technical know-how through hands-on more practical sessions.
- The students will be motivated through assignments, group discussion, effective communication through seminars and presentations and continuous assessment would prepare the students for successful bright carriers in research, education, industry or entrepreneurial ventures in the plant sciences.
- In the revised syllabus, the emphasis has been given to skill development of students by incorporating project work in the final semester if the institution ready to implement.
- New syllabus equips the students of M.Sc., Botany with a strong base in phytochemical, biochemical, molecular and research methods.

M.Sc., Botany [Post Graduate] Choice - Based Credit System (CBCS) Syllabus (2025-26)

CORE SUBJECT: BOTANY; DEGREE: M.Sc., BOTANY

I SEMESTER-700 Marks							**Credits 26**
Course Code	**Course(s)**	**Hrs/ Week L:P**	**Total Contact Hrs**	**Max. Marks (T/P)**	**IA Marks**	**Total Marks**	**Credits**
HCT101	Microbiology and Plant Pathology	4:0	64	70	30	100	4
HCT102	Algae, Bryophytes, Pteridophytes & Gymnosperms	4:0	64	70	30	100	4
HCT103	Taxonomy of Angiosperms	4:0	64	70	30	100	4
HCT104	Economic Botany & Ethnobotany	4:0	64	70	30	100	4
SCT105	Algal & Fungal Biotechnology	3:0	48	70	30	100	2
HCP106	Practical-1 HCT 101 & HCT 102	0:4+4	64+64	70	30	100	4
HCP107	Practical-2 HCT 103 & HCT 104	0:4+4	64+64	70	30	100	4
Field Tour: The student shall undertake a field trip for a minimum of 2-3 days to a floristic rich area.							

II SEMESTER-700 Marks							**Credits: 26**
HCT201	Reproductive Biology of Angiosperms & Plant Morphogenesis	4:0	64	70	30	100	4
HCT202	Plant Anatomy, Propagation and Aquaculture	4:0	64	70	30	100	4
HCT203	Cell and Molecular Biology	4:0	64	70	30	100	4
HCT204	Genetics, Plant Breeding & Evolutionary Biology	4:0	64	70	30	100	4
SCT 205	Phytochemistry and Herbal Technology	3:0	48	70	30	100	2
HCP206	Practical-3 Course HCT 201 and HCT 202	0:4+4	64+64	70	30	100	4
HCT207	Practical-4: Course HCT 203 and HCT 204	0:4+4	64+64	70	30	100	4

III SEMESTER-700 Marks							Credits 24
Course Code	**Course(s)**	**Hrs/ Week L:P**	**Total Contact Hrs**	**Max. Marks (T/P)**	**IA Marks**	**Total Marks**	**Credits**
HCT301	Plant Physiology and Stress Biology	4:0	64	70	30	100	4
HCT302	Biotechnology	4:0	64	70	30	100	4
HCT303	Genetic Engineering & Genome Editing	4:0	64	70	30	100	4
HCP304	Practical-5 Course HCT 301 & HCT 302	0:4+4	64+64	70	30	100	4
HCT305	Practical-6 Course HCT 103	0:4+4	64+64	70	30	100	4
OET306	Plants and Human Welfare	4:0	64	70	30	100	4

IV SEMESTER-700 Marks							Credits: 24
HCT401	Ecology, Phytogeography and Conservation Biology	4:0	64	70	30	100	4
HCT402	Seed Science and Technology	4:0	64	70	30	100	4
HCT403	Plant Biochemistry	4:0	64	70	30	100	4
SCT404	Methods in Biology**	4:0	64	70	30	100	4
HCP405	Practical-7 Course HCT 401, HCT 402	0:4+4	64+64	70	30	100	4
SCP406	Practical-8 Course HCT 403, SCT 404 **	0:4+4	64+64	70	30	100	4
SCPW 407	**Project Work***	0:8	128	160	30	200	8

***Project Work:** The department can also offer a project work to a student in the beginning of a third semester with a suitable Research Supervisor. A student shall complete a Project Work of 8 credits in the Department or in any other University or Research Institute under the guidance of a Research Supervisor. A project report duly signed by the student and the Research Supervisor shall be submitted for evaluation during viva-voce examination. **If the Project Work (SCPW 407) is offered, the student need not study one soft core (SCT404) and one soft core practical (SCP 406) courses of 8 credits.

Semester- Wise Credit Patterns

I Semester = 26 (HC- 24 + SC- 02)
II Semester = 26 (HC- 24 + SC- 02)
III Semester = 24 (HC- 20 + OE- 04)
IV Semester = 24 (HC- 16 + SC- 08)

Total Hard-Core credits to be earned by the students = 84
Total Soft-Core credits to be earned by the students = 12
Total Open Elective credits to be earned by the students = 04
Total number of credits required for qualifying M.Sc. Botany course = 100

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SCHEME OF EXAMINATION/ASSESSMENT
MODEL QUESTION PAPER (THEORY)
M.Sc., Degree ------Semester Examination May/June-20--
BOTANY
Course: ……
Course Code……..

Time: 3 Hrs **Max Marks: 70**

Instructions: 1) Answer all questions.
2) Draw neat and labelled diagrams wherever necessary.

I. Answer the following; (12 short questions) **10 X 2 = 20**

3 from Unit I
3 from Unit II
3 from Unit III
3 from Unit IV

II. Answer the following (6) **4 X 5 = 20**

1 from Unit I
1 from Unit II
1 from Unit III
1 from Unit IV
2 from any Two units

III. Answer the following (3) **3 X10 = 30**

1 from Unit I
1 from Unit II
1 from Unit III
1 from Unit IV
1 from any Unit

SCHEME OF PRACTICAL EXAMINATION/ASSESSMENT
MODEL QUESTION PAPER (PRACTICALS)
M.Sc., Degree I/II/III/IV Semester Examination May/June-
BOTANY
Course: ……Course Code……

Time: 3 Hrs **Max Marks: 70**

Q I. Conduct Experiment/Micro-preparation /Plant identification (A)	15
Q II. Minor experiment/ Demonstrations/ Procedure Writing (B)	10
Q III. Critically comments (3x5 Marks) C D & E	15
Q IV. Identification 5 x 2 Marks) F G H I & J	10
Q V. Viva-voce examination	10
Q VI. Class Records/ Submissions	10

(Minor changes in the model QP can be made by the course in-charge teacher for smooth conduction of practical examination)

***Project Work** (200 Marks) shall be evaluated as under- Dissertation-100; IA-30 Marks; Viva-Voce-70 Marks (Oral Presentation- 40 Marks and Questions and Answers -30 Marks).

I SEMESTER: HARD CORE THEORY-HCT-101
MICROBIOLOGY AND PLANT PATHOLOGY

Credits-04 **Theory-64 Hrs**

Learning Objectives: Aim of this course is to introduce the students *to the new world of microscopic dimensions of life forms, their diversity, pattern of nutrition, reproduction and economic importance. In addition, students are also focused to learn aspects related to plant disease caused by microbes and their management.*

Course Outcome: *Course provides immense knowledge on both basic as well as applied aspects of microbes and their practical utility. Further course also provides practical skills on identification of plant diseases, diagnosis and their effective management.*

Unit-1: Microbiology: Microbial Diversity and its Significance. Advances in Microbiology, Hierarchical organization and position of microbes in the living world. Place of viruses in the living world. Emerging trends in Microbiology. Exploration of plant and animal microbiome and their significance. Understanding horizontal gene transfer in microbial evolution. Microbial applications in Biotechnology, Human and Plant Health, Agriculture and Environment.

Unit-2: Virology and Bacteriology: Origin and evolution of viruses; Classification of viruses- ICTV and Baltimore Systems; Genome diversity in viruses; Transmission of viruses; General structure and replication of DNA and RNA viruses; Viroids - Structure and multiplication of PSTVd; Prions and prion diseases. Classification of Bacteria by Bergey's Manual of Determinative and Systematic Bacteriology; Three domain classification - Archaebacteria and Eubacteria and Erkaryotes, Genetics and Recombination in bacteria. Mycoplasmas and Phytoplasmas; Economic aspects of Viruses and Bacteria.

Unit -3: Mycology: Present status of fungal diversity and its significance; Outline system of classification of fungi.; General nutrition and reproduction in Fungi. Genetics of Fungi. Fungal genomes, analysis and diversity. Evolution of sex in fungi; Heterothallism and Para-asexuality; Life cycle patterns and phylogeny of major taxonomic groups. Novel fungi and their untapped potential. Fungal Diagnostics. Fungi based nanoparticles and their applications. Current trends, limitations and future research in fungi.

Unit-4: Plant Pathology: Scope of plant pathology; Plant diseases and crop losses; Classification and Plant disease diagnostics; Parasitism and disease development; Effect of pathogen on physiology of host; Host range of pathogens; Defence Mechanisms in Plants; Plant Disease epidemics and plant disease forecasting; Methods of plant disease management; Study of plant diseases- Sandal Spike, Citrus Canker, Bacterial Blight of Paddy, Late Blight of Potato, Downy Mildew of Bajra, Tikka Disease of Ground nut, Grain Smut of Sorghum. Phloem Necrosis of Coffee, Root Knot Disease of Mulberry. Integrated disease/Pest management (ID(P)M).

Suggested Readings:

1) Madigan, M.T. 2012. Brock Biology of Microorganisms, 13th edn. Benjamin Cummings.
2) Willey, J, Sherwood, L. and Woolverton, C.J. 2013. Prescott`s Microbiology 9th edn. Mc Graw-Hill Educations.
3) Wagner, E.K, and Hewlett, M.J. 2009. Basic Virology. Blackwell Science Ltd. 2nd edn. USA.

4) Kodo, C.I. and Agarwal, H.O. 1972. Principles and Techniques in Plant Virology, Van Nostrand, Reinhold Company, New York.
5) Conrat, F.H., Kimball, P.C. and Jay, L. 1988.Virology. Prentice Hall, Englewood Chiff, New Jersy.
6) Jawaid, A. Khan and Jeanne Dijkstra. 2002. Plant Viruses as Molecular Pathogens. Food Products Press, NY
7) Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 2013. Introductory Mycology 4th edn. Wiley.
8) Singh, R. S. 2009. Plant Disease. 9th edn. Oxford and IBH Pub. Co., New Delhi.
9) Agrios, G. N. 2005. Plant Pathology 5th edn. Academic Press, San Diego.
10) Rangaswamy, G. and Mahadevan, A. 2002. Diseases of crop plants in India, Prentice Hall of India Pvt.Ltd. New Delhi.
11) Mehrotra, R. S. 2003. Plant Pathology. 2nd edn. Tata Mc Graw-Hill Pub. Co. Ltd., New Delhi.
12) Cann, A.J. 2012. Principles of Molecular Virology 5th edn. Elsevier Ltd, USA.
13) Flint, S.J. Enaquist, L.W., Rancnicllo, V. R. and Skalka, A.M. 2009. Principles of Virology pathogenesis and control. 3rd edn. APS Press, USA.
14) Hall, R. 2014. Plant Virology, 4th edn. Elsevier, USA.
15) Aneja, K.R. 2003. Experiments in Microbiology plant Pathology and Biotechnology, 4th edn. New Age International Publishers, New Delhi.
16) Holt, J.G., Krige, N.R., Sneath., P.H.A. Stuley, J.T. and Williams, S.T. 2010. Bergey`s Manual of Determinative Bacteriology, 9th edn. Williams and Wilkins, USA.
17)Dickinson, M. 2003. Molecular Plant Pathology, Garland Publishing Inc, CT.
18) Ingram,D.S. and Robertson, N.F. 1999. Plant Diseases, Collins Publishers, London.
20) Lane, C.R., Beales P.A. and Hughes, K.J.D. 2012. Fungal Plant Pathogens, CABI Publishing, Wallingford.
21) Rangaswamy, G. and Mahadevan, A. 2002. Diseases of crop plants in India, Prentice Hall of India, Pvt.Ltd. New Delhi.
22) Schumann, G. L. and D'Arcy, C. J. 2012. Hungry Planet: Stories of Plant Diseases, APS Press, USA.
23) Singh, R. S., 2009. Plant Diseases. 9th edn. Oxford and IBH Pub.Co. New Delhi.

I SEMESTER: HARD CORE THEORY-HCT-102
ALGAE, BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS

Credits-04 **Theory-64 Hrs**

Learning Objectives: *Students are offered to learn core concepts on the lower plants such as Algae, Bryophytes, Pteridophytes and Gymnosperms and their evolutionary relationships. Students study the comparative account of ecological adaptation and reproduction in different divisions including economic importance.*

Course Outcome: *Students are well expertise in identification of different forms of algae, bryophytes, pteridophytes and gymnosperms. They also learn about the economic and ecological significance of lower forms of plants. This course will form a foundation to understand further higher plant's structure and functions.*

Unit-1: Algae: Diversity and distribution of algae; Unicellular, colonial, filamentous, heterotrichous, parenchymatous, pseudoparenchymatous, siphonous forms; General characteristics, classification and phylogeny of algae; Pigmentation in algal groups; Role of

photosynthetic and accessory pigments; Life cycles in algae - haplontic, diplontic, isomorphic, heteromorphic; Ecological and economic importance of algae.

Unit -2: Bryophytes: Introduction, general characteristics, classification and phylogeny of Bryophytes; Distribution, habitat, external and internal morphology and reproduction; Comparative account on gametophytes and sporophytes of bryophytes; Ecological and Economic significance of Bryophytes.

Unit -3: Pteridophytes: Introduction, classification and phylogeny; Morphology, anatomy reproductive biology and phylogeny; Psilophytes, Lycophytes, Sphenophytes, Filicophyta; Evolution of sorus; evolution of sporangium; Gemetophyte development - homosporous and heterosporous ferns; Heterospory and seed habit; Stelar evolution in Pteridophytes; Ecology of Pteridophytes and their economic importance.

Unit- 4: Gymnosperms: Distribution, general characteristics, classification and phylogeny of Gymnosperms; Range in morphology, anatomy, reproduction and interrelationships of - Cycadales, Ginkgoales, Coniferales, Gnetales; Pteridosperms; Economic importance of Gymnosperms.

Suggested Readings

1) Bower, F.O. 1935. Primitive land plants, Macmillan, London.
2) Campbell, D. H. 1972. Evolution of land plants (Embryophytes), Central Book Department Allahabad.
3) Watson, E.V. 1971. The structure and life of Bryophytes Hutchinson and Co. Ltd. London.
4) Parihar, N.S. 1970 An Introduction to Embryophyta Vol. 1. Bryophyta. Central Book Department, Allahabad.
5) Prempuri, 1981. Bryophytes, Morphology, Growth and Differentiation. Atmaram and sons, New Delhi.
6) Nayar, M.C., Rajesh, K.P. and Madhusoodanan, P.V. 2005. Bryophytes of Wyanad.
7) Murthy, A.V.S.S. 2005. A text book of algae. IK International Pvt., Ltd., New Delhi.
8) Bold, H. C. and Wynne, M.J. 1978. Introduction to the algae. Structure and reproduction. Prentice Hall.
9) Chapman and Chapman. 1973. The Algae. Macmillan Co., New York.
10) Fritsch, F. E. 1935. Structure and Reproduction of Algae Vol. I & II. Cambridge Univ. Press, London.
11) Odum, E.P. Fundamentals of Ecology. 3rd edn. Toppan Co., Ltd., Japan.
12) Round, F. E. 1973. Biology of the algae. Edward Arnold Ltd., London.
13) Smith, G.M. 1951. Manual of Phycology. Pub. Co. Waltham., Mass.
14) Venkataraman, G.S. 1974. Algae form and function. Today & Tomorrow's Pub., New Delhi.
15) South, G. R. &Whittick, A. 1987. Introduction to Phycology. Blackwell Scientific Publication, UK.
16) Hoek, V., Mann, D. G. & Johns, H. M. 1995. An introduction to Phycology. Cambridge University Press, UK.
17) Biswas, C. and Johri, B. M. 1997. The Gymnosperms. New Age Publishers, New Delhi.
18) Rashid A. 1986. An Introduction to Pteridophytes. Vikas, New Delhi.
19) Sporne K. R. 1969. Morphology of Gymnosperms. Hutchinson University Library, London.
20) Sporne, K. R. 1969. Morphology of Pteridophytes. Hutchinson University Library, London.

21) Chase, M.W. and Reveal, J.L. 2009. A phylogenetic classification of the land plants to accompany APG III. Botanical Journal of the Linnean Society, 161: 122-127.
22) Sundararajan, S. 2007. Introduction to Pteridophyta. New Age International Publishers, New Delhi.
23) Vashishta, P.C. (2008). Botany for Degree Students: Pteridophyta. S. Chand & Co. Ltd., New Delhi.

I SEMESTER: HARD CORE THEORY-HCT-103
TAXONOMY OF ANGIOSPPERMS

Credits-04 **Theory-64 Hrs**

Learning Objectives: *To understand the principles of classification, identification and nomenclature of flowering plants. Students will learn to recognize and describe key morphological features of angiosperm families along with their representative examples. Students will be practical skills to identify plants using taxonomic keys, herbaria and digital tools to identify plant species.*

Course Outcome: *Studying angiosperm taxonomy helps student to identify the unknown plants correctly. This would help the students to classify and name the flowering plants based on their evolutionary relationship. It enhances their understanding of higher plant diversity and their ecological roles. This knowledge is essential for fields like agriculture, pharmacology and conservation biology.*

Unit-1: History and development of plant taxonomy. Plant classification systems-artificial, natural and phylogenetic systems; Contributions of Carolus Linnaeus, Michel Adanson, de Jussieu, de Candolle to plant classification; Concepts of taxonomic hierarchy; Taxonomic Categories-Genus concept; Species concept; Intraspecific categories; subspecies; varieties and forms; History of botanical nomenclature; ICBN and ICN aims and principles; Rules and recommendations; Rule of priority; Typification; Author citation, Legitimate and illegitimate names; Name changes and synonyms; Effective and valid publication; Herbarium and its significance; Botanical gardens.

Unit-2: **Taxonomic Resources:** General taxonomic indices, world floras and manuals; Monographs and revisions; Bibliographies, catalogues and reviews; Periodicals, glossaries and dictionaries; Hortus Malabaricus; Taxonomic websites-IPNI, Plant List, Tropicos, Botanico-Periodicum-Huntianum (BPH); Biodiversity Heritage Library (BHL); Botanicus, Index Herbariorum; Taxonomic Keys- bracketed keys, indented keys, numbered keys, edge punched and body punched keys.

Unit-3: Study of plant classification Systems; Broad outlines of Bentham and Hooker's system, Engler and Prantl's system, Hutchinson's system, Takhtajan's system, and Cronquist's system; Numerical Taxonomy-principles, selection of characters, merits and demerits; Angiosperm Phylogeny Group (APG) III & IV classification; Study of angiosperm families-Magnoliaceae, Nympheaceae, Urticaceae, Droseraceae, Asteraceae, Podostemaceae, Balanophoraceae, Loranthaceae, Alismataceae, Cyperaceae, Commelinaceae, Dioscoreaceae and Orchidaceae.

Unit-4: Molecular Systematics: Nuclear, mitochondrial and chloroplast genes. Gene sequencing, analysis of molecular data, alignment of sequences; Phylogenetic tree construction-Maximum Likelihood and Neighbour Joining Methods; Phylogenetic analysis-

rooted and unrooted trees; Data analysis- alignment, substitution, model building; Phylogenetic software-CLUSTAL W, MEGA, Mesquite, PAUP, PHYLIP, Tree finder, Tree Base.

Suggested Readings

1) Cronquist, A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York.
2) Simpson, M.G. 2006. Plant Systematics. Elsevier, Amsterdam.
3) Swafford, D.L. 2001. PUAP. Phylogenetic Analysis Using Parsimony, version 4. Sinauer Associates, Sunderland.
4) Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.A. and Donoghue, M.J. 2002. Plant Systematics: A phylogenetic Approach. Sinauer Associates, Inc., Massachusetts.
5) Gurucharan Singh. 2004. Plant Systematics: Theory and Practice, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6) Jeffrey, C. 1982. An introduction to Plant Taxonomy. II Edn., Cambridge Uni. Press.
7) Mondal, A.K. 2009. Advanced Plant Taxonomy. New Central Book Agency Pvt. Ltd., Kolkata, WB.
8) Pullaiah, T. 1998. Taxonomy of Angiosperms. Regency Publications, New Delhi.
9) Johri, B.M. and Bhattacharjee, S.P. 1994. Taxonomy of Angiosperms. Narosa Publishers, New Delhi.
10) Lawrence, G.H.M. 191. Taxonomy of Vascular Plants. MacMillan, London.
11) Chase, M.W. and Reveal, J.L. 2009. A phylogenetic classification of the land plants to accompany APG III. Botanical Journal of Linnaean Society, 161: 122-127.
12) Nei, M. and Kumar, S. 2000. Molecular Evolution and Phylogenetics. Oxford Univ. Press, New York
13) APG-IV. 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants APG-IV. Botanical Journal of Linnaean Society, 181: 1-20.

I SEMESTER: HARD CORE THEORY-HCT-104
ECONOMIC BOTANY AND ETHNO-BOTANY

Credits-04 **Theory-64 Hrs**

Learning Objectives: *Learning economic botany helps students understand the importance of plants in everyday life, focusing on their economic uses. It also enables them in identification and classification of commercially valuable plants and their products. Students study the cultivation, processing, and sustainable use of plant resources. Ethnobotany and Intellectual Property Rights (IPR) include understanding the relationship between indigenous communities and their use of plants for medicinal, cultural, and economic purposes. Students will explore traditional knowledge systems and the significance of biodiversity in sustaining cultural heritage.*

Course Outcome: *The course in economic botany and ethnobotany equips students with knowledge about the economic significance and uses of various plants. It enables them to identify and classify plants with commercial and medicinal value. This prepares them for careers in agriculture, pharmaceuticals, forestry, and related industries. Upon completing the course on Ethnobotany, students will be able to recognize and appreciate the value of*

traditional plant knowledge held by indigenous communities. They will gain the ability to analyze the cultural, ecological, and economic significance of ethnobotanical practices.

Unit- 1: Economic Botany: The origin of cultivated plants and Agriculture; The future role of plants in relation to mankind; Introduction to Green revolution; Study of origin, distribution, cultivation and utility of the useful parts of the following- - rice, wheat, maize, barley, sorghum and millets; Red gram, green gram, black gram, horse gram, pea, cow pea, Bengal gram; Oil Yielding plants- sunflower, safflower, groundnut, linseed, rape seed; A brief account of economically important horticultural and floricultural plants. Study and utility of the useful parts of the following- Sugar yielding plants- sugar cane and sweet potato, sugar beet and *Stevia*; Spices and condiments - ginger, turmeric, cardamom, cinnamon, clove, saffron, all spice, black pepper, nutmeg, red pepper, coriander, cumin, fennel and *Vanilla.*

Unit -2: Economic Botany Study and utility of the useful parts of the following- fibre- cotton, jute, flax, hemp, Sun Hemp, China grass, coconut and Kapok; Timber yielding plants- *Tectona* and *Dalbergia*; Dyes- indigo, henna; Masticatories and fumitories-areca nut, betel leaf, tobacco; rubber- Para rubber and other substitutes; Gums- Gum Arabic, Karaya gum. **Medicinal Botany:** Scope and importance of medicinal plants; Indigenous medicinal Sciences; Important medicinal plants and their uses; Major exporters and importers of traditional medicinal plants and plant products; Application of natural products to certain diseases- jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases; Poisonous plants.

Unit-3: Ethno-botany: Introduction, concept, scope and objectives; Ethno-botany as an interdisciplinary science; The relevance of ethno-botany in the present context; Ethnic groups; Ethno-botany- Major and minor ethnic groups of India and their life styles; Forest Vs. ethnic groups; Plants in tribal life with reference to Magico-religious rituals and social customs; Sacred groves. Methodology used in the study of Ethnobotany and Ethno pharmacology: Field work, Herbarium, Ancient Literature, Archaeological findings, temples and sacred places, protocols. Preliminary phyto-chemical analysis of ethno-botanical important medicinal plants.

Unit-4: Ethno-botany as a tool to protect interests of ethnic groups; Sharing of wealth concept with few examples from India. Bio-piracy of traditional knowledge; Ethno botany and legal aspects; National and international organizations and treaty related to traditional knowledge – WIPO, TKDL, TRIPS, CBD, Nagoya protocol etc., Ethno botany as a source (recent) of already known drugs: a) *Withania* as an antioxidant and relaxant b) *Sarpagandha* in brain ailments c) *Becopa* and *Centella* in epilepsy and memory development in children d) *Phyllanthus fraternus* in diabetic and viral jaundice e) *Artemisia* as a powerful cerebral anti-malarial agent and its possible use in tuberculosis.

Suggested Readings

1) Hill, A.F. 1952. Economic Botany, Tata McGraw Hill, New Delhi.
2) Kochhar, S.L. 1998. Economic Botany of Tropics, McMillan India Publishers, New Delhi.
4) Pandey, B.P. 2000. Economic Botany. S. Chand & Company, New Delhi.
5) Pandey, S.N. and Chandha, A. 1999. Economic Botany. Vikas Publishing House Pvt. Ltd. New Delhi.
Jain, S.K. 1995. Manual of Ethno-botany, Scientific Publishers, Jodhpur.
Jain, S.K. 1981. Glimpses of Indian. Ethno-botany, Oxford and I B H, New Delhi

S.K. Jain 1989. Methods and approaches in ethno-botany. (ed.) Society of Ethno Botanists, Lucknow, India.
Jain, S.K. 1990. Contributions of Indian ethno-botany. Scientific Publishers, Jodhpur.
Colton C.M. 1997. Ethno-botany – Principles and applications. John Wiley and sons –
Rama Ro, N and A.N. Henry (1996). The Ethno-botany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
Rajiv K. Sinha – Ethno-botany The Renaissance of Traditional Herbal Medicine – INA – SHREE Publishers, Jaipur-1996.
Faulks, P.J. 1958. An introduction to Ethno-botany, Moredale pub. Ltd. London.

I SEMESTER: SOFT CORE THEORY -SCT-106
ALGAL AND FUNGAL BIOTECHNOLOGY

Credits-02 **Theory-48 Hrs**

Learning Objectives: *Learning/ studying algal and fungal biotechnology enables students to understand and their diversity in different ecosystems and their identification and documentation for future sustainable applications. The modern biotechnology principles can be used to harness the uniqueness of these organisms to produce products of high economic value.*

Course Outcome: *The course in algal and fungal biotechnology equips students utilize these unexplored organisms using biotechnological methods for their improvement for societal applications. This also prepares them for various careers opportunities in research and innovation industries.*

Unit-1: Fungal Biology and Biotechnology: General characteristics and importance of fungi in human life; Fungi in genetic and applied research; Fungi as model organisms. Estimation of Fungal diversity-classical and molecular methods. Macro fungi and micro fungi living on plant substrata; Lignicolous macro fungi; Lichenized fungi; Sequestrate fungi; Endophytic fungi; Saprobic soil fungi; Fungi in stressful environment; Mutualistic, arbuscular, and endomycorrhizal fungi; Yeasts; Fungi in fresh and marine water habitats; Fungi as parasites of humans and plants; Fungi associated with animals, insect, arthropod and nematodes; Coprophilous fungi. Fungal Fermentation and Food Products: Single cell proteins-Myco-proteins; Fungal secondary metabolites-antibiotics, immunosuppressive agents, anti-tumour agents, fungal toxins as medicines; Fungal pigments; Steroid transformation; Mushroom cultivation; The fungal communities of composts; Fungal interactions and practical exploitation; Heavy metals in fungi-accumulation and sorption; Biotechnology of wood rotting fungi.

Unit-2: Algal Biology and Biotechnology: General characteristics, algal classification, affinities and phylogeny- polyphasic approach; Molecular markers for phylogenetic study; Algal physiology- ultra-structure of cells; Photosynthesis and respiration. **Algal blooms and Toxins:** Blooms produced by algal groups; Toxins produced by cyanobacteria, diatoms, dinoflagellates, prymnesiophytes and euglenoids. **Fresh water and marine water algae.** Algal culture techniques; general principles; physical parameters; culture media; strain improvement; **Algal cultivation methods-**conventional, advanced; **Cultivation of microalgae-*Spirulina*** and ***Dunaliella***. **Cultivation of macroalgae- *Porphyra.*** Algae as Pollution indicators, treatment of waste water plants, heavy metal toxicity and phyco-remediation; Bio-fouling and

biofuel production; Algal products as sources of nutraceuticals; Food colorants; Aquaculture feed; Therapeutics and cosmetics; Medicines; Dietary fibres from algae and uses; Biotechnological applications of algal silica and oils.

Suggested Readings

1) Alexopoulos, C. J., Mims, C. W. and Blakwell, M. 2007. Introductory Mycology 4th edn. Wiley India, New Delhi.
2) Deacon, J. W. 1997. Modern Mycology 3rd edn. Blackwell Science publishers, London.
3) Mehrotra, R.S. and Aneja, K.R. 1990. An Introduction to Mycology, New Age International (P) Limited, New Delhi.
4) Mueller, G M; Bills, GF and Foster, M.S. 2004. Biodiversity of Fungi, Elsevier Academic Press, New York.
5) Rai, M. and Bridge, P.D. 2009. Applied Mycology, CABI International, UK.
6) Carlile, M.J. Watkinson, S.C. and Gooday, G.W. 2001.The Fungi, 2nd edn. Academic Press, USA.
7) Webster, J. and Weber, R.W.S. 2007. Introduction to Fungi. 3rd edn. Cambridge University Press, Cambridge.
8) Bold, H. C. and Wynne, M. J. 1978. Introduction to the algae. Structure and reproduction. Prentice Hall, New York.
9) Chapman and Chapman, V.J. 1973. The Algae. Macmillan Co., New York.
10) Fritsch, F. E. 1935. Structure and reproduction of Algae Vol. I &II. Cambridge University Press, London.
11) Hoek, V., Mann, D. G. and Jahns, H. M. 1995. An introduction to Phycology, Cambridge University Press, UK.
12) Murthy, A.V.S.S. 2005. A text book of algae. I.K. International Pvt., Ltd., New Delhi.
13) Odum, E. P. Fundamentals of Ecology. 3rd edn. Toppan Co., Ltd., Japan.
14) Round, F. E. 1973. Biology of the algae. Edward Arnold Ltd., London.
15) Southcott,G.R. & Whittick, A.1987.Introduction to Phycology. Blackwell Scientific, UK.
16) Venkataraman, G.S.1974. Algae form and function. Today and Tomorrow's, New Delhi.
17) Bux *et al.* (eds.). 2016. Algae Biotechnology: Products and Processes, Springer.
18) Chu, W. 2012. Biotechnological Applications of Microalgae. IeJSME 6(1): S24-S37.

I SEMESTER: HARD CORE PRACTICAL -HCP-105
MICROBIOLOGY, PLANT PATHOLOGY, ALGAE, BRYOPHYTES PTERIDOPHYTES AND GYMNOPSERMS

Credits-04 **Total Practical Hours -64+64**

MICROBIOLOGY & PLANT PATHOLOGY

1) Laboratory guidelines, design, tools, equipment and other requirements for studying microorganisms.
2) Measuring the dimensions of microorganisms using Micrometry.
3) Determining total count of microbes using Haemocytometer.
4) Preparation of NA, PDA, sterilization, pouring, inoculation and culturing of bacteria/fungi.
5) Identification of major groups of fungi.
6) Splash liberation of spores from diseased plant leaf (Leaf spot of *Murraya koenigii*).
7) Estimation of total phenols in diseased and healthy plant tissues.
8) Isolation of bacterial, fungal, and nematode plant pathogens of crop plants.

9) Estimation of foliar infection by Stover's method.
10) Mycoflora analysis by Standard Blotter Method SBM/agar plating method.
11) Study of effect of pathogens on seed germination and vigour index.
12) Study of effect of fungicide on seed-borne pathogens.
13) Study of Fungal bio-control agents.
14) -16) Study of the following diseases: Sandal Spike, Citrus canker, Bacterial Blight of paddy, Late Blight of Potato. Downy Mildew of Bajra, Tikka disease of ground nut, Grain smut of Sorghum, Phloem Necrosis of Coffee, Root Knot disease of Mulberry.

ALGAE, BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS

1-4) Algae: Study of Cyanophyceae: *Anabaena, Oscillatoria*; Study of Chlorophyceae: *Oedogonium, Pediastrum;* Study of Phaeophyceae: *Turbinaria, Ectocarpus*; Study of Rhodophyceae: *Gracilaria, Batrachospermum*; Economic products of algae.

5-7) Bryophytes: Study of morphology, anatomy and reproductive morphology - Hepaticopsida- *Marchantia, Dumortiera*; Anthocerotopsida- *Anthoceros, Notothylas*; Bryopsida- *Bryum* and *Polytrichum.*

8-10) Pteridophytes: Study of vegetative habit, anatomy and reproductive morphology of *Psilotum, Lycopodium, Isoetes, Ophioglossum, Botrychium, Angiopteris, Pteris, Hymenophyllum, Marselia, Salvinia, Azolla;* Paleobotany- Study of Lepidodendrales, Calamitales, Sphenophyllales and Coenopteridales (Fossil Pteriodophytes).

11-12) Gymnosperms: Study of morphology, anatomy and reproductive morphology of *Zamia, Pinus* and *Ephedra, Ginkgo, Auracaria, Podocarpus, Gnetum, Agathis, Cupressus, Thuja*; Economic importance of Gymnosperms.

I SEMESTER: HARD CORE PRACTICAL -HCP-106
TAXONOMY OF ANGIOSPERSMS, ECONOMIC BOTANY ETHNOBOTANY

Credits-04 **Total Practical Hrs-64+64**

TAXONOMY OF ANGIOSPERSMS

1-3) Methods of preparation and maintenance of Herbaria.
4-6) A field trip of three days to a floristically rich area to study plants belonging to different families (Every student shall submit a report for evaluation for two credits).
7-12) Identification of the flowering plants in and around Mysore using keys, floras and monographs.
13-16) Construction of phylogenetic tree based on molecular data of plant species retrieved from GenBank.

ECONOMIC BOTANY & ETHNOBOTANY

1) Utility, uses and economic importance of cereals and millets.
2) Utility, uses and economic importance of horticultural and floricultural plants
3) Utility, uses and economic importance of pulses and oil yielding crops.

4) Utility, uses and economic importance of sugar yielding crops.
5) Utility, uses and economic importance of spice and condiments.
6) Utility, uses and economic importance of fibre and timber yielding plants.
7) Utility, uses and economic importance of dye, rubber and gum yielding plants
8) Utility, uses and economic importance of masticatories and fumitories
9) Study of medicinal and poisonous plants.
10) Survey and collection important ethno-botanical plants by using questionnaire and interview.
11) Preliminary phyto- chemical analysis of medicinal plants.
12) Study of biological functional properties of crude drugs – Anti microbial activity.
13) Study of methods of *in-situ* or *ex-situ* conservation of important medicinal plants.
14) Study of techniques used in Pharmacognosy – organoleptic, anatomy and chemical methods.
15) A visit to a Tribal area to conduct field work and collect ethno-botanical information.
16) Listing of Crude drugs in Pansari shops (local crude drugs shops) and their identification (little known drugs only).
17) Visit to nearby Western Ghats and Sacred Groves.

II SEMESTER: HARD CORE THEORY-HCT-201
REPRODUCTIVE BIOLOGY OF ANGIOSPERMS AND PLANT MORPHOGENESIS

Credits-04 **Theory-64 Hrs**

Learning Objectives: *The study of developmental biology of angiosperms focuses on understanding the processes of flower development, pollination, fertilization, and seed formation that ensure successful reproduction. It explores the mechanisms of sexual reproduction, including the structure and function of male and female gametes, and the role of pollinators. Students will also learn the molecular basis of plant development. Plant morphogenesis examines how plants develop their shape and structure from cells to tissues, highlighting the genetic and environmental factors influencing growth patterns. Together, these topics aim to provide a comprehensive understanding of how angiosperms reproduce and develop, which is essential for applications in agriculture, horticulture, and plant breeding.*

Course Outcome: *Upon completion of this course, students will be able to explain the key concepts and mechanisms involved in the reproductive biology of angiosperms, including flower development, pollination, fertilization, and seed formation. They will gain insights into the molecular, cellular, and anatomical aspects of plant reproduction and their evolutionary significance. Students will also understand the principles of plant morphogenesis, including how genetic and environmental factors influence plant growth and form. Overall, the course will equip learners with the knowledge required to analyze and apply concepts in plant development, breeding, and biotechnology.*

Unit-1: Plant Embryology: Historical overview; Contributions of P. Maheshwari; BM Johri; BGL Swamy to the development of embryology in India; Microsporogenesis and Micro-gametogenesis- wall layers and functions; Tapetum- types, concept of male germ unit and its significance; Pollen morphological features; Unusual features-pollen development in Cyperaceae, pollen embryo sac; Concept and scope of palynology. Molecular basis of understanding developmental aspects in plants-a brief account.

Unit-2: Megasporogenesis and Mega-gametogenesis; Ovular structure and types; Development of monosporic, bisporic, tetrasporic and special types of embryo sacs; Ultra structure and nutrition of female gametophyte, concept of female germ unit and its significance; Fertilization- a general account, double fertilization, single fertilization, heterofertilization and polyspermy; Pollen recognition and rejection reactions - types, structures, methods to overcome incompatibility reactions; Endosperm- types, haustorial variations, ruminate and composite endosperm; Embryo- structure, development of monocot, dicot and grass embryo; Significance of embryonal suspensor; Experimental Embryology-scope and applications.

Unit-3: Plant Morphogenesis: Models of morphogenesis- comparison of plant v/s animal morphogenetic pathways: Embryo, *Arabidopsis thaliana*; Concepts- cell fate/ fate maps, gradients, stem cells in plants and their significance in development, polarity, symmetry,

totipotency of cell types, pleuripotency, plasticity, differentiation, redifferentiation, dedifferentiation and regeneration in *Acetabularia* and *Arabidopsis thaliana.*

Unit-4: Plant Growth and Development: Types, shoot apical meristems, root meristems; control of cell division in meristems; Quiescent center and meristeme de attente; *Arabidopsis*-vascular patterning and leaf development, abnormal growth; Cellular basis of growth-maintenance of cell shape; Cytoskeletal elements; Photomorphogenesis- definition, history, Hartmann's technique; Photoreceptors and photo morphogenesis, localization and properties; Effect of blue light-mediated photomorphogenesis with suitable examples.

Suggested Readings

1) Johri, B. M. 1984. The embryology of Angiosperms. Springer Verlag.
2) Johri, B. M. 1982. The experimental embryology of vascular plants. Springer Verlag, New York.
3) Swamy, B.G.L. & Krishnamurthy, K. V. 1982. From flower to fruit: The embryology of angiosperms. Tata McGraw Hill Co. New Delhi.
4) Eames, 1961. Morphology of Angiosperms. McGraw Hill book Co., Inc., New York.
5) Maheshwari, P. 1950. An introduction to the embryology of Angiosperms. McGraw Hill book Co., Inc., New York.
6) Maheshwari, P. 1963. Recent advances in the embryology of angiosperms. ed. New Delhi
7) Bhojwani, S. S.and Bhatnagar, S. P. 1978. The embryology of Angiosperms. Vikas Publishing House, New Delhi.
8) Turing, A. M. 1952. The chemical basis of morphogenesis. Phil. Trans. R. Soc. Lond. B. 237: 37- 72.
9) Sinnot, E. W. 1960. Plant Morphogenesis. Mc Graw- Hill Book Co. Inc. New York, USA.
10) Steeves, T.A. and Sussex, I. M. 1989. Patterns in Plant development. 2nd edn. Cambridge University Press. UK.
11) Chasan, R. 1994. Tracing tracheary element development. The Plant Cell 6:917-919.
12) Lyndon, R. F. 1990. Plant Development: The Cellular basis. Unwin Hyman, London.
13) Aloni, R. 1987. Differentiation of vascular tissues. Annu. Rev. Plant Physiol. 38:179- 219.
14) Raman, A. 2007. Insect induced plant galls of India; unresolved questions. Curr. Sci. 92 (6): 748-757.

II SEMESTER: HARD CORE THEORY -HCT-202
PLANT ANATOMY, PLANT PROPAPAGATION & AQUACULTURE

Credits-04 **Theory-64 Hrs**

Learning Objectives: *Learning anatomy and histochemistry enables students to understand the structure and organization of the plants at both macroscopic and microscopic levels. It helps in identifying tissues and organs based on their cellular composition and histological features. It courses also covers the principles and methods of plant propagation including aquaculture along with various sexual and asexual propagation techniques used in agriculture and horticulture.*

Course Outcome: *The course in anatomy and histochemistry equips students with a comprehensive understanding of the structural organization of the plants and its tissues. It enables them to identify and differentiate various cells, tissues, and organs through*

microscopic examination. This knowledge forms the basis for studying ontogeny of different organs and their differentiation and also to trace biochemical basis of differentiation. Students will be able to look for job opportunities in nurseries and aquaculture industries.

Unit-1: Plant Anatomy: Primary vegetative body of the plant; Anatomical features of leaf, stem and root (dicot and monocot); leaf of fern and gymnosperm; Structure of modified leaves- Kranz anatomy and C4 photosynthesis; Ultra-structure and chemistry of the cell wall; formation of the cell wall and its uses. **Anatomy of Vascular Tissue:** Ultra structure and differentiation of xylem and phloem tissues; Apical meristems- shoot apex in Pteridophytes, Gymnosperms and Angiosperms, theories, root apical meristems.

Unit -2: Plant Anatomy: Secondary Growth- Vascular cambium, secondary xylem of gymnosperms and dicots and secondary phloem of Gymnosperms and dicots; Periderm and bark; Anomalous secondary growth in monocots and climbers; Leaf ontogeny - Dicot- simple, compound, Monocot; Floral anatomy-flower parts, floral meristem, vascular system. **Plant Histochemistry**: Tests for minerals, carbohydrates, lignins, polyphenols, proteins, lipids and nucleic acids; Study of instruments: (a) Camera lucida (b) Micrometry (c) Microtome. Principles of histo-chemical stains; Killing, fixing and staining of plant tissues; Double staining- TBA method.

Unit-3: **Plant Propagation:** History, scope and importance of plant propagation; Propagation structures with reference to greenhouse equipment and media; Seed propagation and vegetative propagation; Propagation by cuttings; Biology and techniques of grafting; Techniques of budding; Layering and its natural modifications; Propagation by specialized stems and roots; Micro propagation – techniques and applications in forestry and horticulture; Limitations and applications of vegetative propagation. Propagation methods of some selected plants – Citrus, Grape, Mango, Mulberry, Hibiscus, Rose, Croton, Eucalyptus.

Unit-4: Aquaculture of Plants: Definition, scope, history, and current global/national scenarios. Pond culture, cage culture, and different intensity levels (extensive, semi-intensive, intensive). Physical, chemical, and biological factors affecting aquatic plant growth and pond productivity. Focus on various types of aquatic plants, including seaweed, macroalgae, and other commercially important species. Combining plant cultivation with other aquaculture components like fish, prawns, or shellfish. Methods for pre-stocking and post-stocking pond management, including dewatering, fertilization, and pest control. Techniques for harvesting aquatic plants and their subsequent processing for commercial products. The economic potential of aquatic plant cultivation and the importance of sustainable practices.

Suggested Readings

1) Abraham, F. 1982. Plant Anatomy. 3rd edn. Pergmon Press. Oxford.
2) Cronquist, S. 1967. Comparative Plant Anatomy- Holt Reinert and Winston, New York.
3) Cutter, D. G. 1971. Plant Anatomy- Part 1, Cell and Tissues Edward Arnold London.
4) Cutter, D. G, 1971. Plant Anatomy- Part 1, Cell and Tissues Edward Arnold London.
5) Eames and McDaniel, 1947. Plant Anatomy. 2nd edn., McGraw Hill, New York.
6) Esau, K. 1965, Plant Anatomy, Joh Wiley and Sons, New York.
7) James, D. Mauseth, 1998. Plant anatomy The Benjamin/ Cummins Publishing Co.Inc.

8) Esau, K. 1979, Anatomy of seed plants- first Wiley eastern reprint. New Delhi.
9) Krishnamurthy, K. V. 1988. Methods in Plant Histochemistry. S. Viswanathan Pvt. Ltd. Madras.

II SEMESTER: HARD CORE THEORY -HCT-203
CELL AND MOLECULAR BIOLOGY

Credits-04 **Theory-64 Hrs**

Learning Objectives: *The course in Cell and Molecular Biology aims to provide students with a comprehensive understanding of cellular structures and the molecular mechanisms that govern key processes such as DNA replication, transcription, translation, and cell signaling. Students will learn how cells communicate, regulate their growth and division, and maintain homeostasis through complex molecular interactions. The course also develops students' abilities to apply laboratory techniques and interpret experimental data relevant to molecular and cellular functions. Overall, it lays a strong foundation for further studies or careers in biomedical research, biotechnology, and health sciences.*

Course Outcome: *Upon completion of the Molecular Cell Biology course, students will be able to explain the structure and function of cellular organelles and understand the molecular basis of key cellular processes such as gene expression, cell signalling, and cell division. They will demonstrate the ability to apply fundamental laboratory techniques and analyze data from molecular and cellular experiments. Students will also develop critical thinking skills to connect molecular events with cellular function and human disease. This course prepares them for advanced studies or careers in research, biotechnology, and healthcare.*

Unit-1: Introduction to cell biology: Cell organs and cytoskeleton; Cell cycle and mechanism of cell cycle regulations; A brief account of cell signalling, receptors, second messengers; General mechanism of signal transduction pathway; Programmed cell death in life cycles of plants. History and Central dogma of Molecular biology. Chromosome structure, organization and types. Organization of chromosomes and genes in prokaryotes and eukaryotes - Operon, interrupted genes, gene families, unique and repetitive DNA, heterochromatin, euchromatin, transposons, mitochondrial and chloroplast genome organization, Transposable elements in prokaryotes and eukaryotes, genetic and evolutionary significance, **DNA replication**- patterns, Mechanism of DNA replication in prokaryotes and Eukaryotes, proof reading and error correction mechanisms.

Unit-2: Protein synthesis, processing and translation: transcription activators and repressors, promoters, RNA polymerases and transcription factors, mechanism of transcription in prokaryotes and eukaryotes, **RNA processing**- capping, polyadenylation, splicing, alternative splicing, RNA editing, exon shuffling and RNA transport, **Translation and processing**- ribosomes, tRNA aminoacylation, aminoacyl tRNA synthetase, genetic code, wobble hypothesis, deciphering of the code, translation mechanism , translation proof reading, translation inhibitors and post translational modifications.

Unit-3: Unit-4: Regulation of gene expression in Prokaryotes: Operon concept, regulation at transcription initiation- lac and trp operon control, regulation of lytic and lysogenic cycles in lambda phage, regulation beyond transcription initiation-premature termination- trp operon,

ribosomal proteins as translational repressors, riboswitches, **Regulation of gene expression in eukaryotes**-transcription activators and repressors, regulation after transcription initiation-alternative splicing, translational control in ferretin and tranferrin mRNA, RNA interference, role of chromatin in regulation of gene expression and gene silencing.

Unit-4: Plants as genetic tools in molecular biology: *Arabidopsis, Rice, Maize, Saccharomyces;* Genome organization in plants; *Arabidopsis thaliana*- an experimental model for understanding plant development and functions; Plant genes and regulation; nucleus and chromatin organization; Histones and histone modifications; DNA packaging, organization and types of DNA sequences; functional and non- functional sequences, organization of plant nuclear genes, plastid genes and mitochondrial genes. Genes responding to hormones, phytochrome, responses to abiotic stresses; Genes induced by water stress and freezing stress; Genes involved in photosynthesis and nitrogen fixation and their regulation; Molecular development of leaf and flower - ABC and revised model of flower development; Genes involved in fertilization, seed development, embryo development.

Suggested Readings

1) Alberts B., Bray D., Lewis J., Raff M., Roberts K., and Watson J. D. 1999. Molecular Biology of the Cell. Garland Publishing Inc., New York.
2) Baxevanis A. D. and Francis Ouellellette B. F. (2009). Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Wiley India Pvt Ltd.
3) Buchanan B. B., Gruissem W. and Jones R. L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
4) Cooper G. M. and Hausman R. E., 2004. The Cell: A Molecular Approach 3rd Ed, Sinaur Associates, Inc Sunderland, Massachusetts.
5) David W. Mount (2001). Bioinformatics: Sequence and Genome Analysis: University of Arizona, Tucson.
6) Gardner E. J., Simmons M. J. and Snustad D. P. 2003. Principles of Genetics, 8th Ed, John Wiley and Sons. Inc., New York.
7) Glick B. R. and Pasternak 1998. Molecular Biotechnology: Principal and Application of Recombinant DNA, 2nd Ed, ASM Press, Washington D.C.Gunning B. E. S. and Steer, M. W. 1996. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers, Boston, Massachusetts.
8) Hartl D. L. and Jones E. W. 2002. Essential Genetics: A Genomic Perspective, 3rd Ed, Jones and Bartlett Publishers, Sudbury, Massachusetts.
9) Hughes M. A. 1999. Plant Molecular Genetics, Addison Wesely Longman Limited, England.
10) Karp G. 2008. Cell and Molecular Biology: Concepts and Experiments, John Wiley and Sons Inc., New York.
11) Lewin B., Lingappa V. R. and Plopper G., 2007. Cells, Jones and Bartlett Publishers, Sudbury, Massachusetts.
12) Lewin B. 2017. Genes XII. Jones and Bartlett publishers, Sudburry, Massachusetts.
13) Lodish H., Berk A., Zipursky S. L., Matsudaira P., Baltimore D. and Darnell J. 2000. Molecular Cell biology, 4th edition, W. H. Freeman and Co., New York, USA.
14) Malacinski G. M., 2003. Essentials of Molecular Biology, 4th Ed, Jones and Bartlett Publishers, Inc Sudbury, Massachusetts.

II SEMESTER: HARD CORE THEORY -HCT-204
GENETICS, PLANT BREEDING AND EVOLUTIONARY BIOLOGY

Credits-04 **Theory-64 Hrs**

Learning objectives: *The course on Plant Breeding covers the principles and methods of plant breeding, along with various sexual and asexual propagation techniques used in agriculture and horticulture. Learning Genetics and Evolutionary Biology helps understand the mechanisms of heredity, variation, and the molecular basis of gene function. It enables students to analyze how evolutionary processes shape genetic diversity within and between populations. The subject fosters skills in interpreting genetic data and understanding evolutionary relationships among organisms. Overall, it prepares students to apply genetic and evolutionary principles in research, medicine, and conservation.*

Course outcome: *Upon completing the course in Plant Breeding students will understand the key principles of crop improvement and propagation techniques. They will be able to apply appropriate breeding and propagation methods for different plant species. The course in Genetics and Evolutionary Biology enables students to explain the principles of inheritance, gene structure, and function. It helps them understand the mechanisms driving evolution, such as mutation, natural selection, genetic drift, and gene flow. Students will gain the ability to analyze genetic data and interpret evolutionary patterns. This knowledge equips them for advanced studies and careers in genetics, biotechnology, evolutionary research, and related fields.*

Unit-1: Extensions of Mendelian Principles co-dominance, incomplete dominance, gene interactions, multiple alleles, lethal alleles, pleiotropy, penetrance and expressivity, polygenic inheritance, linkage and crossing over, sex linked inheritance, sex limited and influenced traits, genome imprinting, extra nuclear inheritance; C**oncept of the gene**- classical-alleles, multiple alleles, pseudo-alleles, complementation test, experiments on rII locus and lozenge locus, modern- jumping genes, overlapping and genes within genes, split genes, nested genes, fusion genes; **Gene mapping methods-** linkage maps, tetrad analysis. **Sex Determination and Dosage Compensation:** Chromosomal and genetic basis of sex determination; Mechanism of sex determination in *Melandrium*. **Transposable elements**- discovery in maize and bacteria, transposal elements in bacteria and bacteriophage, types and functions; Transposable elements in eukaryotes. Mechanisms of transpositions; Transposable elements in research.

Unit-2: Plant Breeding- Objective and role of plant breeding; Evolution of plant breeding, scope of plant breeding, sciences related to plant breeding, Vavilov's concept of origin of centers of origin of crop plants; Recent trends in plant breeding; **Breeding Methods-**plant introduction and acclimatization, domestication and agriculture, pure line, clonal, mass and progeny selections, recurrent selection, pedigree, bulk and back cross methods; Heterosis breeding synthetic and composite varieties; **Breeding Techniques-**Mutation breeding, polyploidy, hybridization, tissue culture techniques in crop improvement, protoplast fusion, electrophoration, electro-fusion, biolistics, somatic hybridization, transgenic plants (GMO's);

Unit-3: Plant Breeding -The role of Gene technology in plant breeding. **Breeding for Specific Purposes:** Breeding for disease resistance, insect resistance, drought and salinity, quality trait,

multiple cropping systems, ideotype breeding, breeding for Adaptation; **Crop breeding and seed production-** Breeding field crops, seed production techniques, release of new varieties, intellectual property rights, computer application in plant breeding, crop breeding Institutes/Centres; Genetic resources and germplasm conservation; Scientific Plant breeding; Green revolution; The elite crop (Golden rice); Contributions of N.I. Vavilov., M.S. Swaminathan, and Norman E. Borlaug.

Unit-4: Evolutionary Biology: A brief account on the origin, theories of evolution of life, earth and the universe. Origin of prokaryotic and eukaryotic cells, **Development of Evolutionary thoughts;** Ecological context, before Darwin, Darwinism, Darwin's evolutionary theory, Neo – Darwinism, modern synthesis. N**atural Selection :** Types of natural selection, selective forces, selection models, sexual selection, selection and non-adaptive characters, Adaptive radiation, artificial selection, **Variation- g**ene flow, genetic drift, gene mutation - Mendelian concept, chromosomal mutation, architectural changes in chromosomes; The Hardy – Weinberg law, polyploidy in plant evolution**;** Speciation and origin of higher categories -Types of speciation, models of speciation, pattern of speciation, isolating mechanism and species formation, signification of speciation; Molecular evolution.

Suggested Readings

1) Alberts, B., Bray, D., Lewis, J, Raff, M., Roberts, K and Watson, J.D. 1999, olecular biology of the cell. Garland Publishing, Inc., New York.
2) Atherly, A.G. Girton, J.R. Donald, J.R. 1999. The Science of Genetics. Saunders College Publishers. Fortworth.
3) Brooker, R.J. 1999. Genetics –analysis and principles. Addison Wesley Longman Inc. California.
4) Brown, T.A. 1989. Genetics a molecular approach. Van Nostrand Reinhold (intn) Co., Ltd. London.
5) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Rafi, Keith Roberts, and Peter Walter. 2008. Molecular biology of the cell, 5th ed., Garland science, Taylor & Francis Group, LLC, 270 Madison Avenue, NewYork NY f 0016, USA.
6) Buchanan, B.B. W. Gruissem and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. ed. ASPP Press.USA.
7) Chahal, G.S. and Gosal, S.S. 2002. Principles and procedures of Plant Breeding. Narosa Publishing House, New Delhi.
8) Chopra, V.L. 2000. Plant Breeding- theory and practices. Oxford and IBH Publishing Co. Pvt. Ltd., Oxford.
9) Fairbanks, D.J. and Anderson, W.R. 1999. Genetics the continuity of Life. Brooks's/Cole publishing Company, California.
10) Futuyma, Douglas J. 2005. Evolution. Sinauer Associates, Inc., 23 Plumtree Road, Sunderland, MA 01375, United States of America
11) Griffith, A.J.F. Gelbart, W.M. Muller, J.H. and Lewintin, R.C. 1999. Modern Genetic Analysis. W.H. Freeman and Co. New York.
12) Hartl. D. 1991. Basic Genetics. 2edn., Jones and Barlett Publishers Inc. Boston.
13) Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology 2nd edn. Harper Collins College Publishers, New York, USA.
14) Lodish, H. Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology, 4th edn. W.H. Freeman and Co. New York, USA.
15) Strickberger, Monroe W. 2000. Evolution. 3rd Ed., Jones & Bartlett Publishers, Inc. 40 Tall Pine Drive Sudbury, MA 01776, United States of America.

II SEMESTER: SOFT CORE THEORY -SCT-205
PHYTOCHEMISTRY AND HERBAL TECHNOLOGY

Credits -02 **Theory-48Hrs**

Learning Objectives: *The learning objectives of phytochemistry and herbal drug technology help the students to understand the chemical constituents of plants and principles and techniques used to identify and analyze bioactive compounds in plants. Students learn how to perform qualitative and quantitative analysis of phytochemicals such as alkaloids, flavonoids, tannins, and saponins. Overall, learners gain practical skills in laboratory techniques essential for natural product research and drug discovery.*

Course Outcome: *The course outcome of curse enables students to proficiently identify, extract, and analyze various phytochemicals present in medicinal plants. Learners develop the ability to apply standard laboratory techniques for the qualitative and quantitative evaluation of plant constituents. The course also enhances understanding of the role of phytochemicals in therapeutic applications and herbal drug development. Ultimately, students are equipped with practical and analytical skills essential for careers in Ayurveda, pharmacognosy, herbal medicine, and natural product research.*

Unit-1: **Phytochemistry:** Scope of phytochemistry, plants as source of chemical compounds, primary and secondary metabolites and its applications; Definition, source of herbal raw materials, identification, authentication, standardization of medicinal plants as per WHO guidelines and different herbal pharmacopoeias; Natural pigments, natural products as markers for new drug discovery. **Extraction, isolation and purification of phytochemicals**: Selection of plant samples, processing and storage of samples for extraction; Factors influencing the choice of extraction, principles of extraction methods, infusion, decoction, digestion, maceration, percolation, solvent extraction, fluid extraction, ultrasound, microwave assisted extraction, advantage and disadvantage involved in each method; Isolation of selected primary and secondary metabolites – amino acids, proteins and carbohydrate; Phenolics, flavonoids, alkaloids, lipids, oils, terpenes and saponins; Purification techniques for primary and secondary metabolites – solvent-solvent fractionation and chromatography techniques.

Unit-2: Characterisation of Phytochemicals: Preliminary, qualitative and quantitative techniques – paper chromatography, thin layer chromatography, column chromatography-HPLC, GC (qualitative and quantitative), colour reactions for amino acids, sugars, phenolics, flavonoids, alkaloids, terpenes, saponins, oils, lipids; Spectroscopic estimations/gravimetric determination of total sugars, amino acids, proteins, phenolics, flavonoids, alkaloids, terpenes, saponins, oils, lipids; Characterisation using spectroscopic techniques - UV/VIS, FTIR, DSC (differential scanning calorimeter), NMR, MS, MALDI. XRD – single crystal and powder. **Standardisation and Validation of Photochemical:** Quality determination of herbal drugs; Role of processing methods and storage conditions on quality of drugs; Standardisation parameters- impurity limit, ash content, extractable matter, moisture content, other phytochemicals, microbial contaminants, pesticides; Validation of drug – guidelines, limit of detection and quantification of impurities, organoleptic properties, physical, chemical, biological characteristics, stability testing, storage conditions and packing system/unit.

Suggested Readings

1) Bourne U. K., Kokate, Purohit C. K. and Gokhale S. B. (1983). Pharmacognosy. Nivali Prakashan Publication.
2) Braithwaite A. and Smith F. J. (1996). Chromatographic Methods (5th edition), Blackie Academic & Professional London.
3) Sadasivam S. and Manickam A. (2005). Bio Chemical methods 2nd edition, New Age International Limited, New Delhi.
4) Bourne, U.K. Kokate, Purohit, C.K. and Gokhale S.B. 1983. Pharmacognosy. Nivali Prakashan Publication.
5) Sadasivam. S. and A. Manickam, 0000. Bio Chemical methods 2nd edn. New Age International Pvt Ltd. New Delhi.
6) Harborne, J.B. 1984. Phytochemical Methods, 2nd edn. Chapman and Hall, London. Harborne J.B., 1973. Phytochemical methods a guide to modern techniques of plants analysis. Chapman and Hall Ltd. London.

II SEMESTER: HARD CORE PRACTICAL -HCP-206
REPRODUCTIVE BIOLOGY OF ANGIOPSERMS AND PLANT MORPHOGENESIS, PLANT ANATOMY, PLANT PROPAPAGATION & AQUACULTURE

Credits-04 **Total Practical Hrs-64+64**

REPRODUCTIVE BIOLOGY OF ANGIOPSERMS AND PLANT MORPHOGENESIS

1) Study of microsporangium - slides: wall layers, tapetal types, two-celled and three-celled pollen; pollen tetrads.
2) Study of pollen germination: *Balsam, Delonix, Hibiscus* and *Peltaphorum*
3) Study of megasporangium-slides: female gametophyte development in *Penstemon, Xyris pauciflora,* 2, 4, 8-nucleate stages, mature embryo sac.
4) Endosperm mounting- *Cucumis sativus, Grevellia robusta* and *Croton sparsiflorus*
5) Embryo: Slides-monocot, dicot and grass embryo.
6) Embryo mounting: *Crotalaria.*

PLANT MORPHOGENESIS

7) Study of stem cells in plants: SAM, RAM.
8) Regeneration abilities of shoot apical meristems of dicots on media with combinations of growth regulators.
9) Study of totipotency in cell types: stomata, epidermal cells, stem and leaf explants on a tissue culture media.
10) Polarity in stem cuttings: *Pothos* spp.
11-12) Study of regeneration in succulents *Kalanchoe, Byrophyllum.*
13-15) Study of leaf galls of plants: *Pongamia pinnata and Achyranthes aspera*: Morphological observations and histology.
16) Study of *Arabidopsis thaliana* as a model plant.

PLANT ANATOMY, PLANT PROPAGATION, AQUACULTURE

1) Staining of xylem and phloem elements.
2) Study of anatomy of roots in: *Ficus, Musa, Dieffenbachia, Vanda.*
3) Study of anamalous secondary growth in the following examples: Stem of *Aristolochia, Nyctanthes, Pyrostegia, Peperomia, Tinospora, Achyranthes*.
4) Study of Ecological anatomy.
5) Study of Vasculature in floral organs.
6) Studying double staining technique.
7-9) Embedding: TBA method, embedding for electron microscope, Sectioning**,** Microtomes, whole mounts maceration.
10) Histochemical- PAS Test**,** Sudan black- lipids**,** Feulgen reaction – Nucleic acids.
11) Demonstration of bud grafting.
12) Demonstration of whip grafting.
13) Demonstratipon of splice grafting.
15) Demonstration of approach grafting.
16) Demonstration of air layering.
17) Demonstration of ground layering.

II SEMESTER: HARD CORE PRACTICAL -HCP-207
CELL AND MOLECUALR BIOLOGY, GENETICS, PLANT BREEDING EVOLUTIONARY BIOLOGY

Credits-04 **Total Practical Hrs-64+64**

CELL AND MOLECULAR BIOLOGY

1) Isolation of DNA plant source by CTAB method.
2) Isolation of DNA from E coli or Saccharomyces.
3) Isolation of plasmid DNA from E. coli.
4) Quantification of DNA and RNA.
5) Determination of reducing sugars by Nelson-Somogyim's method.
6) Estimation of total soluble sugars by volumetric method.
7) Quantitative determination of free Amino acid content in germinating seeds.
8) Estimation of ascorbic acid in plant tissues.
9) Estimation of Phospholipids by TLC and spectrophotometer
10-12) DNA isolation and restriction digestion and separation and analysis by submarine electrophoresis.
13-16) Prediction of amino acid sequence from DNA sequences, Sequence homology determination. Method of phylogenetic tree construction.

GENETICS, PLANT BREEDING AND EVOLUTIONARY BIOLOGY

1) Mendelian Genetics: Problems related to Dihybrid and monohybrid cross, Problems related to Non-Mendelian inheritance: Co-dominance, epistasis-dominant and recessive.
2) B-chromosome squash preparation in *Trigonella* root.
3) Polytene chromosome squash preparation.
4) Study of genetics in *Neurospora crassa*

5) Study of genetics in *Saccharomyces cerevisiae***.**
6) Study of genetics in *Sordaria fimicola***.**
7) Calculation of chiasma frequency.
8) Study of the Hardy-Weinberg principle.
9) Study on the effect of selection on allelic frequency.
10) Sorting and determination of seed coat color allelic frequency in *Eleusine coracana* and *Macrotyloma uniflorum*.
11) Linkage problems- 3-point test cross, tetrad analysis.
12) Induction of polyploidy using colchicine.
13) Techniques in Hybridization: Emasculation, bagging and labelling.
14) Demonstration of uses of breeding implements.
15) Demonstrations: Floral biology of crops - typical examples of self and cross-pollinated plants, selfing.
16) Mode of pollination study in different crops.
17) Pollen viability: germination test and TTC test.
18) Studying of centres of origin of cultivated crops - N.I. Vavilov Concept.
19) Identification of crop breeding institutes/ centers and logos.
20) Studying and identification of contributors of plant breeding - M.S. Swaminathan, N.I. Vavilov, Norman, E. Borlaug.
21) Contributions of Evolutionary Biologists. Models and Photographs related to evolution.

III SEMESTER: HARD CORE THEORY-HCT-301
PLANT PHYSIOLOGY AND STRESS BIOLOGY

Credits-04 **Theory-64 Hrs**

Learning Objectives: *This course provides an underlaying of physiological processes in plants, including cell differentiation, organ development, and flowering. It covers water and nutrient transport, mineral nutrition, and the role of plant hormones in growth and development. Students will also study photosynthesis, photoreceptors, biological rhythms, and plant responses to environmental stresses such as drought, salinity, and temperature.*

Course Outcome: *This course focuses on the functional aspects of plants, providing essential knowledge of cellular processes and physiological mechanisms. It serves as a foundational course for understanding how plant cell function, which is crucial for advanced learning in related fields such as molecular biology, biotechnology, and genetics. By building a strong conceptual base, the course also offers significant potential for students pursuing higher studies and research in plant sciences and allied disciplines.*

Unit-1: lute transport and photo assimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; mechanisms of loading and unloading of photo assimilates. Water relations: water requirement, Transpiration; mechanism and factors affecting anti transpirants. Mineral Nutrition: Elements found in plants, essential elements, quantitative requirements and tissue analysis, functions, Nutrient deficiency.

Unit-2: Photosynthesis: Structure of chloroplast and its function, concept of pigment system, Light harvesting complexes; Red drop and Emmersons enhancement effect. Electron transport system, cyclic and noncyclic photophosporylation, ATP synthesis, photolysis, alternate oxidase; photorespiratory pathway. Photoprotective mechanisms; CO2 fixation-C3, C4 pathways and CAM cycle. **Photorespiration** - C4 – Pathway, CAM in plants; Oxidative Phosphorylations; Glycolysis -TCA – Cycle and terminal oxidation.

Unit-3: Hormones and growth regulators – biosynthesis, storage, breakdown, transport, physiological effects. Mechanisms of action of auxins, gibberellins, cytokinins, ethylene, abscissic acid; mechanism of flowering, fruit ripening, abscission, senescence hormone receptors. Application of growth hormones and retardants in agriculture and horticulture. Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement.

Unit -4: Stress Physiology: Water deficit and its physiological consequences; Drought tolerance mechanisms, Salinity stress and plant responses. Heat stress and heat shock proteins; Metal toxicity in plants. Biotic stress, HR and SAR mechanisms; **Mineral nutrition**- in plants and deficiency diseases; **Plant development**- physiology of flowering; **Phytochrome**- photochemical and biochemical properties of phytochrome; Concept of photoperiodism and vernalization and its influence on flowering.

Suggested Readings

1) Barkla, B.J., and Pantajo, O. 1996. Physiology of ion transport across the tonoplast of higher plants. Ann. Rev. Plant Physiol. 47: 159-184.
2) Clayton, R.K. 1980. Photosynthesis: Physical mechanisms and chemical patterns. Cambridge, Uni. Press, Cambridge.
3) Cohn, E.E., and Stumf, P.K. 1992. Outlines of Biochemistry. Wiley Eastern Pvt. Ltd.
4) Kozaki, A., and Takeba, G. 1996. Photorespiration protects C3 plants from photooxidation. Nature 384: 557- 560.
5) Taiz, L., and Zeiger, E. 1998. Plant Physiology. Sinaur Associates Inc. Publishers, Sunderland, Massachusetts.
6) Mukherji, S., and GHosh, A.K. 1996. Plant Physiology. New Central Book Agency Pvt. Ltd. Kolkatta, India.
7) Rabinowithc, E., and Jee, G. 1969. Photosynthesis. Willey Press, New York.
9) Spanswick, R.M. 1981. Electrogenic ion pumps. Ann. Rev. Plant Physiol. 32: 267-289.
10) Mc Elroy, W.D. 1995. Cell Physiology and Biochemistry. Prantice Hall of India.
11) Walsh, C.T. 1979. Enzymatic reaction mechanisms. Editors: W.H. Freeman, New York.
12) Webb, E. 1984. Enzyme nomenclature. Academic Press, Orlando Fla.
14) Devline and Witham, 1986. Plant Physiology. CBS Publs. and Distributors, New Delhi.
15) Hopkins, W.G. 1995. Introduction to Plant Physiology, John Wiley & Sons. Inc., NewYork, USA.
16) Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones. Springer Verlag, New York, USA.
17) Singhal *et al*. 1999. Concepts in Photobiology, Photosynthesis and Phytomorphognesis, Narosa Pub. House, New Delhi.

III SEMESTER: HARD CORE THEORY-HCT 302
BIOTECHNOLOGY

Credits-04 **Theory-64 Hrs**

Learning Objectives: *Learning course in biotechnology enables students to understand basic concepts of plant cell for improving plant traits. It helps them to develop skills in applying biology methods in plant research. This knowledge supports innovations in medicines, food, crop improvement, disease management, and sustainable agriculture.*

Course Outcome: *The course in biotechnology equips students with the ability to apply genetic engineering techniques for plant improvement. Students gain practical skills in molecular markers and genome mapping. This prepares them for careers in research, agriculture, and biotechnology industries.*

Unit-1: Biotechnology: Introduction to biotechnology, types, scope of biotechnology, recent developments in biotechnology. Laboratory organization, basic principles of cell and tissue culture. Culture media: types and composition of media, preparation, sterilization, Role of macronutrients, micronutrients, organic nutrients, growth regulators and gelling agents, undefined supplements, different carbon sources used in tissue culture media. Micropropagation of Plants; Plasticity and totipotency. Explant selection, induction of callus, meristem culture, embryo culture, applications and limitations.

Unit 2: Plant cell Biotechnology: Cell suspension culture: Isolation of cells, types, synchronization, assessment of growth and viability; techniques and factors affecting single cell culture; Haploids and triploids production techniques. Protoplasts isolation, culture techniques, fusion, selection, characterization of somatic hybrids, cybrids. Applications and limitations of somatic hybridization. Root cultures, Shoot tip and Meristem culture. Embryo culture, Microspore culture. Plant regeneration- Somatic embryogenesis, Organogenesis. Applications of plant tissue culture. Synthetic seeds and their applications.

Unit-3: Microbial Biotechnology: Biofertilizers: Preparation and applications of biofertilizers such as *Rhizobium*, *Azotobacter*, *Azospirillium*, Blue Green Algae, VAM and *Azolla*. Single Cell proteins (SCP): Health benefits and advantages of single cell proteins- *Spirulina*, *Chlorella*, *Scenedesmus*; Yeast as SCP. Mycoproteins. Biofuels: Bio-fuels production; Ethanol, Biogas, Hydrogen and their applications. Biofuel production from plants. Healthcare Products from Plants: Anticancer agents from higher Plants. Pharmaceuticals from Fungi. Plant Secondary metabolites and their pharmaceutical applications. Plant vaccines.

Unit-4: Environmental Biotechnology: Biological waste treatment and reuse of wastes: Waste treatment, Steps, Reuse of wastes; Conversion of wastes in biogas; Ethanol and compost. Seaweeds and Marine biotechnology: Exploring seaweeds for food, fodder, pharmaceuticals and therapeutic agents. Bioremediation: Cleaning environment; In-situ bioremediation. Phytoremediation. Biodegradation: Xenobiotics; Biodegrading agents; Treatment of Toxic pollutants, Advantages of Biodegradation. Biotechnology of medicinal and aromatic plants: Cultivation and exploitation of medicinal and aromatic plants for human welfare.

Suggested Readings

1) Bhojwani, S.S. and Razdan, M.K. 2004. Plant Tissue Culture: Theory and practice. Elsevier Science Publishers, New York, USA.
2) Brown, T.A. 2000. Essentials of Molecular Biology. Vol. I & II, Oxford University Press.
3) Buchmann, B.B., Gruissem, W., and Jones, R.L. 2000. Biochemistry and Molecular
4) Chawla H.S., 2009, Plant Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
5) Draper, J. 1988. Plant Genetic Transformation and Gene Expression. Blackwell Scientific
6) Gilmartin, P.M., and Bowler, C. 2002. Molecular Biology of Plants. Oxford
7) Karchar, S.J. 1995. Molecular Biology- A Project Approach, Academic Press, New York.
8) Lea, P.J., and Leegood, R.C. 1999. Plant Biochemistry and Molecular Biology. John
9) Mark Flower, Oxford University Press, (2000). Plant Genetic Transformation and Gene Expression by (eds) J.Draper *et.al*. Blackwell Scientific Publications, Oxford
10) Old, R.W., and Primrose, S.B. 2004. Principles of Gene Manipulation. An introduction to Plant Biotechnology -The Genetic Manipulation of Plants.
11) Adrian Slater, Nigel Scott and Plant Biotechnology. 2000. J.H. Hammond, P. Mcgarvey, and V. Yusibov (eds). Springer
12) Potrykus, I., and Spangenberg, G. 1995. Gene transfer to plants. Springer, Berlin, Heidelberg. Publications, Oxford.
13) Purohit, S. D., 2012. Introduction To Plant Cell Tissue and Organ Culture PHI Learning Pvt. Ltd., New Delhi
14) Reinert, J. 1982. Plant Cell and Tissue Culture: A Laboratory Manual. Narosa Publishing House, New Delhi.

15) Roberta, H. Smith, 2012. Plant Tissue Culture: Techniques and Experiments 3 edition. Academic Press; US.
16) Slater, A., Scott, N., and Flower, M. 2000. Plant Biotechnology- the Genetic Manipulation of Plants, Oxford University Press, Oxford.
17) Struhl, K. 2005. Current protocols in molecular biology. Current Edition. Text Book of Biotechnology. 2004.
18) Watson, J.D., and Baker, T.A., Bell, S.P. Gannm, A. and Levine, M. 2004. Molecular Willey and Sons Press, New York.

III SEMESTER: HARD CORE THEORY-HCT 303
GENETIC ENGINEERING AND GENOME EDITING

Credits-04 **Theory-64 Hrs**

Learning objectives: *Learning genetic engineering enables students to understand genetic manipulation techniques for improving plant and microbial traits. It helps them develop skills in applying molecular biology methods in plant research. This knowledge supports innovations in crop improvement, disease management, and sustainable agriculture. Students will also learn about modern genome editing tools such as CRISPR-Cas and their applications in enhancing desirable traits in plants. Through this course, learners will develop practical skills and scientific knowledge essential for advancing sustainable agriculture and plant biotechnology.*

Course Outcome: *The course in genetic engineering equips students with the ability to apply genetic engineering techniques for plant improvement. Students gain practical skills in molecular markers and genome mapping. This prepares them for careers in research, agriculture, and biotechnology industries. The course also provides foundational knowledge of genome editing tools like CRISPR-Cas and their applications in trait enhancement. Students will be equipped to contribute to sustainable agriculture through modern plant biotechnology, considering ethical and regulatory aspects.*

Unit-1: Genetic Engineering: Milestones in plant recombinant DNA technology; Importance of gene manipulation in future perspectives; **Tools in Genetic Engineering**-Enzymes in genetic engineering - restriction endonucleases, types and their actions, other DNA modifying enzymes; Cloning vectors- plasmids isolation and purification - Ti Plasmid, pBR322, pUC-series. Phage vectors-M13 phage vectors, Cosmids -types, phasmids or phagemids, shuttle vectors-types; YAC and BAC vectors, Lambda phage vectors, Lamda phage DNA as a vector; Cloning vectors and expression vectors; Vectors for plant cells; Vectors for animal cells, baculovirus vectors- adenoviruses, retroviruses, transposons as vectors, Synthetic construction of vectors.

Unit 2: Applications of genetic engineering: Strategies for engineering herbicide resistance, the environmental impact of herbicide-resistant crops, **S**trategies for insect resistance, *Bacillus thuringiensis* approach to insect resistance, insect resistant crops and food safety. Transgenic approaches to viral and bacterial disease resistance. Engineering for stress tolerance: The nature of abiotic stress, the nature of water deficit stress, targeted approaches towards the manipulation of tolerance to specific water deficit stresses.

Unit-3: Metabolic Engineering of Plants- plant cell culture for the production of useful chemicals and secondary metabolites (hairy root culture, biotransformation, elicitation), pigments, flavanoids, alkaloids; mechanism and manipulation of Shikimate pathway, therapeutic proteins. Future prospects for GM crops- **t**he current state of transgenic crops, concerns about GM crops, the regulations of GM crops and products.

Unit 4: Genome editing: Introduction to Genome Editing**.** Genome Editing Technologies CRISPR-Cas9 System: Mechanism, components, and applications. Other Genome Editing Tools: ZFNs, TALENs, and other technologies**.** Delivery Method. Applications in Crop Improvement. Model Systems: Studying genome editing in model plants and translating findings to crop species. Off-target Analysis: Evaluating and mitigating off-target effects. Transgene-free Mutants. Molecular Analysis of Edited Lines. Handling Genome-Edited Plants: Regulatory and Ethical Considerations. Public Perception and Acceptance: Addressing concerns about genome-edited crops. Ethical Issues**.** Case Studies and Future Directions. Examples of Genome-Edited Crops: Highlighting successful applications in various crops. Emerging Technologies: Exploring new advancements in genome editing and their potential.

Suggested Readings

1) Adrian Slater, Nigel Scott and Mark Flower (2000). Plant Biotechnology -The Genetic Manipulation of Plants, Oxford University Press.
2) Bhojwani, S. S. and Razdan M. K. 2004. Plant Tissue Culture: Theory and practice. Elsevier Science Publishers, New York, USA.
3) Chawla H. S. 2009. Plant Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
4) Chrispeels M. J., and Sadava D. E. 1994. Plants, Genes and Agriculture, Jones and Bartlett Publishers, Boston, USA.
5) Das H. K. (2004). Text Book of Biotechnology: (ed). Wiley India Pvt. Ltd., New Delhi.
6) Draperet J. *et al.,* (1988). Plant Genetic Transformation and Gene Expression: Blackwell Scientific Publications, Oxford.
7) Evans D. E., Coleman J. O. D. and Kearns A. 2008. Plant cell culture. Bio Scientific Publ. London.
8) Giri C. C. and Giri A. 2007. Plant Biotechnology Practical Manual, I K International Publishing House Pvt Ltd.
9) Hammond J. H., Mcgarvey P. and Yusibov V.(eds)(2000). Plant Biotechnology: Springer Verlag, Heidelberg.
10) Mount D. (2004). Sequence and Genome Analysis: Cold Spring Harbor Laboratory Press, New York. 2004.
11) Purohit, S. D. 2012. Introduction To Plant Cell Tissue and Organ Culture PHI Learning Pvt. Ltd., New Delhi.
12) Roberta H. Smith, 2012. Plant Tissue Culture: Techniques and Experiments, 3rd edn. Academic Press; US.
13) Slater N. Scott and Fowler M. (2003). Plant Biotechnology: The genetic manipulation of plants. Oxford University Press, Oxford.

III SEMESTER: HARD CORE PRACTICAL HCP-304
PLANT PHYSIOLOGY AND STRESS BIOLOGY, BIOTECHNOLOGY

Credits-04 **Total Practical Hrs-64**

PLANT PHYSIOLOGY AND STRESS BIOLOGY

1) Determination of water potential of tissue by plasmolytic method
2) Determination of water potential by Gravimetric method
3) Quantitative estimation of chlorophyll a, chlorophyll b and total chlorophyll in plant tissue
4) Determination of diurnal fluctuation of acid content of CAM plants (TAN)
5) Determination of temperature quotient (Q10) of water uptake
6) Separation of chlorophyll pigments/Anthocyanin by TLC
7) Estimation of Alpha-amylase activity in germinating seedlings.
8) Determination of diffusion pressure deficit.
9) Determination of water potential using scholander pressure chamber.
10) Determination of stomatal frequency, stomatal index and the area of stomatal aperture.
11) Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.
12) To determine the chlorophyll a /chlorophyll b ratio in C3 and C4 plants.
13) Anatomical characters of C3, C4 and CAM plants.
14) Physiological adaptations in plants - xerophytes, mesophytes, hydrophytes.
15) Estimation of vitamin-C (Ascorbic acid) in plants.
16) Assay of nitrate/nitrite reductase activity in leaves/algae.
17) Estimation of proline under stress and normal condition.
18) Demonstration experiment Warburgh monometer
19) Isolation of polysaccharide (starch) from plant source.
20) Estimation of protein by Lowry's method

BIOTECHNOLOGY

1) Biotechnology lab design organization, sterilization techniques, nutrition medium.
2) Preparation of MS culture media.
3) Micropropagation of Plants through shoot tip culture and anther culture.
4) Callus induction, organogenesis – shooting, rooting, hardening from different explant sources.
5) Embryo culture.
6) Laboratory scale production of wine.
7) Industrial production of ethanol from sugar and its estimation alcohol meter.
8) Preparation of biofertilizers such as Rhizobium and seed testing.
9) Single cell protein production-Shake flask culture- Spirulina and Chlamydomonas and its quantification by Lowry's method.
10) Biogas production from waste from anaerobic digester.
11) Detection of secondary metabolites in callus.
12) Study of DNA integrity of Allium cepa root cells under the influence of xenobiotics.
13) Isolation of starch and its morphological characterization using SEM.
14) Isolation of pectin and its confirmation using FT–IR.
15) Preparation of Synthetic seeds
16) Isolation and separation of nucleic acid.

III SEMESTER: HARD CORE PRACTICAL HCP-305*
GENETIC ENGINEERING AND GENOME EDITING

Credits-04 **Total Practical Hrs-64+64**

GENETIC ENGINEERING AND GENOME EDITING

1) Isolation of genomic DNA from *E.coli*
2) Isolation of genomic DNA from plant cells by CTAB method.
3) Isolation of RNA by Lithium chloride method and Separation of RNA 2D PAGE.
4) Separation and purification nucleic acids by agarose gel electrophoresis.
5) Restriction digestion of plasmid and genomic DNA and gel electrophoresis.
6) Restriction analysis of plasmids, gel purification of DNA, small- and large-scale purification of plasmids.
7) DNA ligation
8) Preparation of competent *E. coli* cells.
1) Isolation of Ti-plasmid.
2) Construction of r-DNA.
3) Bacterial Transformation.
4) Co-cultivation of Ti-plasmid and plant cells.
5) Bacterial transformation and recovery of plasmid clones.
6) Gene cloning in plasmids, analysis of recombinant plasmids.
7) Gene expression studies.
8) DNA amplification by PCR, RT-PCR, Real Time PCR.
9) Analysis of DNA and RNA and Protein by Southern, Northern and Western blotting.
10) Primer design for PCR.
11) Demonstration of Southern, Northern and Western Blotting techniques.
12) *Arabidopsis thaliana*- study of plant system and its biology.
13) *Arabidopsis* RNA extraction (total and polysomal) for Northern blotting.
14) Expression of foreign genes in plant cells through *Agrobacterium tumefaciens* (Chart)
15) Production of tobacco transgenic plants and assay for the introduced transgenic
16) Co-cultivation of tobacco *Agrobacterium tumefaciens*
17) Learning gene bank formats- EMBL format, FASTA format, Swiss- PROT, Ex PASy
18) Models: Genome editing in plants.

*This practical imparts molecular biology and genetic engineering skills and each practical need double the duration of the 3hrs. Hence 64+64 hrs given for HCP-305.

III SEMESTER: OPEN ELECTIVE THEORY: OET-306
PLANT DIVERSITY AND HUMAN WELFARE

Credits-04 **Theory-64 Hrs**

Learning Objectives: *The course on Plant Diversity and Human Welfare aims to provide students with a broad understanding of the interactions between plant diversity and their environments, and the importance of plant diversity for ecosystem health. Students will learn about the principles and methods of conservation biology to protect endangered species and habitats. The course also covers the distribution patterns of plants across geographical regions and the factors influencing these patterns. Through this, students will develop the knowledge and skills necessary to address environmental challenges and promote sustainable management of natural resources.*

Course Outcome: *Upon completion of the course, students will be able to analyze ecological importance of plant diversity and its significance to human society. Students will also be able to explain the distribution of plant species across different geographical regions and the environmental factors influencing these patterns. This course equips students with the skills to contribute to environmental management, conservation efforts, and sustainable development initiatives.*

Unit -1: Plant Biodiversity: Role of plant diversity in ameliorating energy crisis and global warming; Types of biodiversity-genetic diversity, species diversity, plant diversity at the ecosystem level; Agro-biodiversity and cultivated plant taxa, wild taxa; **Values and uses of Biodiversity**- Ethical and aesthetic values, precautionary principle, methodologies for valuation, uses of plants and microbes.

Unit -2: Loss of Biodiversity: Major causes of for biodiversity loss; Loss of genetic diversity, Loss of species diversity; Loss of ecosystem diversity; Loss of agro-biodiversity; Projected scenario for biodiversity loss; Management of Plant Biodiversity- Organizations associated with biodiversity management; Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations; Biodiversity information management and communication.

Unit -3: Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, social approaches to conservation, Biodiversity awareness programmes, Conservation of Heritage Trees. **Role of plants in relation to Human Welfare:** Importance of forestry their utilization and commercial aspects, Avenue trees, Ornamental plants of India, Alcoholic beverages through ages, Fruits and nuts-Fruit crops of Karnataka and their commercial importance; Wood and its uses.

Unit -4: Biodiversity Convention: IUCN categories, Red Data book and Red lists, invasive alien species as threat to biodiversity; Conservation strategies- past, present, and future; Attitudes about conservation; conservation movements; CITES (Convention on international trade in endangered species), WCU (World Conservation Union); Endangered species Act. 2002 (GOI); Protected areas, Network of India- history, size, scale and management.

Suggested Readings

1) Krishnamurthy K. V. 2007. An Advanced Textbook on Biodiversity: Principles and Practice. Oxford & IHB Publishing Co. Pvt. Ltd. New Delhi.
2) Christian Leveque and Jean-Claude Mounolou, 2003. Biodiversity. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England.
3) Jeffries Michael J. 2006. Biodiversity and conservation, 2nd edn. Taylor and Francis Group, New York.

IV SEMESTER: HARD CORE THEORY- HCT 401
ECOLOGY AND PHYTOGEOGRAPHY & CONSERVATION BIOLOGY

Credits-04 **Theory-64 Hrs**

Learning objectives: *The course on Ecology, phytogeography, Conservation Biology aims to provide students with a broad understanding of the interactions between organisms and their environments, and the importance of biodiversity for ecosystem health. Students will learn about the principles and methods of conservation biology to protect endangered species and habitats. The course also covers the distribution patterns of plants across geographical regions and the factors influencing these patterns. Through this, students will develop the knowledge and skills necessary to address environmental challenges and promote sustainable management of natural resources.*

Course Outcome: *Upon completing the course on Ecology, Conservation Biology, students will be able to analyses ecological relationships and understand the significance of biodiversity in maintaining ecosystem stability. They will demonstrate knowledge of conservation strategies aimed at protecting endangered species and habitats. Students will also be able to explain the distribution of plant species across different geographical regions and the environmental factors influencing these patterns. This course equips students with the skills to contribute to environmental management, conservation efforts, and sustainable development initiatives.*

Unit-1: Introduction to Ecology: Plants and the environment- plant adaptation, ecotypes, habitat ecology- fresh water and marine water ecology (ecosystems), wetlands and their characteristics; Ecosystem function; The distribution of biomes; Major Terrestrial Biomes; Forests-Tropical Forests-Temperate Forests, Taiga, Grasslands, Savanna, Temperate Grasslands/Prairies, Tundra, Desert and Chaparral.

Unit-2: Phytogeography: Biogeography of the world, India and Karnataka; Climatic zones, tectonics, continental movements; Types of plant distribution – discontinuous distribution - land bridge theory, continental drift; continuous distribution-cosmopolitan, circumpolar, circumboreal, circumaustral, pantropical; Distribution of plants - islands; Phytochorea of the world, India; Plant dispersal, migrations and isolation; Endemic plants of Western Ghats and Eastern Himalayas; Origin, distribution and acclimatization of coffee, cardamom, sugarcane, cashew, ragi, maize, wheat, rice and cotton; Remote sensing and GPS, study of vegetation by GIS (Geographical Information system).

Unit-3: Environmental Issues: Global warming: Greenhouse gases - causes and consequences; Ozone depletion- causes and consequences; Air, water and soil pollution - major pollutants, their source, permissible limits - and control methods; Radioactive pollution- Ionising radiation, disposal of radioactive waste, nuclear accidents; Environmental Education

Programmes - WWF, UNEP, MAB; Role of plants in solving energy crisis and ameliorating global warming.

Unit-3: Biodiversity and Conservation: Science in the service of Biodiversity, biodiversity and its value, biodiversity issues, concerns, management; Biodiversity hot spots; Biodiversity-threats and current status of biodiversity; IUCN categories, Red Data book and Red lists, invasive alien species as threat to biodiversity; Conservation strategies- past, present, and future; Attitudes about conservation; conservation movements; CITES (Convention on international trade in endangered species), WCU (World Conservation Union); Endangered species Act. 2002 (GOI); Protected areas, Ramsar lakes, Network of India- history, size, scale and management; Heritage trees.

Suggested Readings

1) Polunin, N. 1961. Introduction to plant geography.
2) Good R.D. 1974. Geography of the flowering plants.
3) James H. B. 1998. Biogeography.
4) Cain, S.A. 1944. Foundations of plant Geography.
5) Croiat, 1952. Manual of Phytogeography.
6) Edgar A. 1972. Plants, Man and Life.
7) Valentine, D. H. 1972. Taxonomy, Phytogeography & Evolution.
8) Phil Gibson J. and Gibson Terri, R. 2006. Plant ecology.
9) Primack, R. B. 2006. Essentials of conservation biology.
10) Ricklefs, R. E. 2001. The Economy of Nature.
11)Narasaiah M. L., 2005. Biodiversity and Sustainable Development.
12)Tondon P, Abrol Y. P, Kumaria S., 2007. Biodiversity and its significance.
14) Krishnamurthy K. V. 2007. An Advanced Textbook on Biodiversity: Principles and Practice.

IV SEMESTER: HARD CORE THEORY-HCT-402
SEED SCIENCE AND TECHNOLOGY

Credits-04 **Theory-64Hrs**

Learning Objectives: *The course covers all the fundamental concepts related to seed science providing students with a strong foundation for seed biology and technology. It introduces methods of seed quality assessment and seed health testing, enabling students to evaluate the viability and integrity of seeds effectively. Practical applications of various seed processing methods are included, equipping students with the skills needed to handle and process seeds efficiently.*

Course Outcome: *The course familiarizes students with all seed testing aspects of seed quality such as seed production, processing, seed storage, seed treatment, seed testing and marketing. This comprehensive knowledge prepares students for employment opportunities in seed production companies. Furthermore, with the skills acquired, students can also establish their own seed production units, thereby contributing to self-employment and job creation in the agricultural sector.*

Unit-1: Seed Technology: Introduction to seed science and technology and its goals; Development of seed technology industry in India; Seed as basic input in agriculture; Seed Biology - Seed development, morphology and anatomy of dicot and monocot seeds; Seed

structure and functions; Seed programmes and organizations; Seed village concept, seed production agencies, seed industry and custom seed production in India; International Seed Science and Technology Organizations.

Unit-2:Seed Production: General principles of seed production in self and cross pollinated and vegetatively propagated crops; Hybrid seed production; Maintenance of inbred lines and breeders seeds; Synthetic and composite seeds; Improved seed and their identification; Germplasm banks; **Seed Processing**-Harvesting, seed drying, seed cleaning and grading; Equipment; Seed Storage- types of storage structure; seed factors affecting storage life, effect of storage on relative humidity, temperature and moisture; Seed deterioration; Seed treatment.

Unit-3: Seed Quality Testing: Devices and tools used in seed testing; ISTA and its role in seed testing; Seed sampling- physical purity and heterogeneity test; Seed moisture content-importance and determination and methods; Viability and vigour testing; Genetic purity testing -objective and criteria for genetic purity testing, seed health testing, field and seed standards, designated diseases, objectionable weeds; Significance of seed borne diseases, seed health testing and detection methods for seed borne fungi, bacteria, viruses and nematodes; Preparation and dispatch of seed testing reports, storage of guard samples, application and use of seed standards and tolerances.

Unit- 4: Seed Certification: Principles and philosophy of seed certification, purpose and procedures, national seed programme; National Seed Corporation (NSC) - agencies responsible for achieving self-reliance in seed production and supply of quality of seeds (State Seeds Corporation; National Seed Development Council (NSDC); Central Seed Committee(CSC) ; Seed market surveys, seed industry in relation to global market; Concept of WTO, GATT, IPR, Plant Variety Protection and its significance seed technology; UPOV and its role.

Suggested Readings

1) ACAR.2009. Handbook of Agriculture. Indian Council of Agricultural Research, New Delhi.
2) ACAR.2013. Handbook of Horticulture. Indian Council of Agricultural Research, New Delhi.
3) Agarawal, P. K. 2005. Principles of Seed Technology.2nd edn. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
4) Basra, A. S. 2006. Handbook of Seed Science and Technology, The Haworth Press, USA.
5) Copeland, L. O. and McDonald, M. B. 2001. Principles of Seed Science and Technology. 4th edn. Chapman & Hall.
6) Copeland, L.A. 1995. Principles of Seed Science and Technology- Kluwer Academic Publishers, The Netherlands.
7) Michael, B. and Bewley, D. 2000. Seed technology and its biological basis. Wiley- Blackwell.
8) Neergaard, P. 2005. Seed Pathology, Palgrave, Macmillan, Denmark. Science, Technology and Uses. CABI, UK.
9) Vanangamudi, K., Natarajan, K., Saravanan, T., Natarajan, N., Umarani, R., Bharathi, A. and Srimathi, P. 2006. Advances in Seed Science and Technology: Vol: III: Forest Tree Seed Technology and Management, Agrobios, New Delhi.

IV SEMESTER – SOFT CORE THEORY SCT-403
PLANT BIOCHEMISTRY

Credits-04 **Theory-64 Hrs**

Learning Objectives: *This course enables students to understand the structure and function of biomolecules, cellular membranes, and metabolic pathways in plants. It covers enzyme kinetics, bioenergetics, signal transduction, and nitrogen metabolism. Students will learn key biophysical techniques such as spectroscopy, chromatography, and electrophoresis. The course also introduces computational tools for binding site prediction and data mining.*

Course Outcome: *This course offers a foundational understanding of plant functions and cellular biochemistry, essential for exploring life processes like growth, transport, and stress response. It prepares students for advanced studies in fields such as molecular biology, biotechnology, and microbiology, while also supporting future research and career development in plant and life sciences.*

Unit-1: Introduction and scope of plant biochemistry: Atomic Structure: chemical bonds- Ionic bond, covalent bond, hydrogen bond; periodic table, Radioactivity, Hydrogen ion concentration(pH), buffer, reaction kinetics. Bioenergetics –Laws of thermodynamics, colligative properties, Concepts of enthalpy, entrophy and free energy. Exergonic and endergonic reactions. Redox potential. Structure and hydrolysis of high energy compound. Plant enzymes -classification, kinetics and mechanism of action. Enzyme inhibition: competitive, non-competitive and uncompetitive inhibition. Michaelis–Menten Equation. Units of enzyme activity.

Unit-2: Carbohydrates: structures, classification, occurrence and their biological role. Metabolism - Glycolysis and its regulation, HMP pathway, Uronic acid pathway, T. C. A. cycle. Mitochondrial structure, Electron Transport System (E. T. S.) and its regulation and oxidative phosphorylation. Factors affecting respiration. Amino acids: classification, structure, properties, biosynthesis and oxidation. Proteins: classification, structures, Ramachandran plot, method of separation and amino acid sequencing.

Unit-3: Lipids: structure, classification, functions, properties and biological role. Biosynthesis And oxidation of fatty acids. Vitamins - classification, distribution, structure, production, function. Isolation of selected primary and secondary metabolites: Amino acids, proteins and carbohydrate, phenolics, flavonoids, alkaloids, lipids, oils, terpenes and saponins. Purification techniques for primary and secondary metabolites – solvent-solvent fractionation and chromatography techniques - HPTLC, silica gel column (normal and reverse), ion exchange, size exclusion. Secondary plant products: structure, biosynthesis and distribution of terpenes, phenolics and nitrogen containing compounds. Signal transduction: Hormones and their Receptors, cell surface receptors, signaling through G-protein coupled receptors, secondary messengers, proteins, phospholipid signaling, role of cyclic nucleotides, calcium - calmodulin cascade, protein kinases and phosphatases. Specific signaling mechanisms in Bacteria and Plants.

Unit-4: Biochemical Techniques: Spectroscopy: Basic principles, instrumentation and applications of UV-VIS absorption, infrared, Raman, fluorescence spectroscopy. Principles of light scattering, Rayleigh scattering, static light scattering, dynamic light scattering, low angle X-ray scattering. Principles, instrumentation and applications of adsorption chromatography, partition chromatography, molecular exclusion chromatography, affinity chromatography, gel electrophoresis, continuous flow electrophoresis, ultracentrifugation. Binding site identification tools: Cast-P, POCASA, 3D ligand site, Meta pocket, Ghecom, QSR. Demonstration of data mining tools: Weka, Rapid miner, Keel.

Suggested Readings

1) Buchanan B. B., Gruissem W. and Jones R. L. 2007. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
2) Dennis D. T., Turpin D. H., Lefebvre, D. D. and Layzell D. B. (eds) 1997. Plant Metabolism. Longman, Essex, England.
3) Dey P. M. and Harborne J. B., 2000. Plant Biochemistry. Academic press, USA.
4) Dryer R. L. and Lata G. F. 1989. Experimental Biochemistry. Oxford University Press, New York.
5) Godwin T. W. and E. I. Mercer 1983. Introduction to Plant chemistry. Pergamon press. USA.
6) Heldt H. W. and Heldt F. 2005. Plant Biochemistry, Academic press, California.
7) Lea P. J. and R. C. Leegood 1993. Plant Biochemistry and Molecular Biology, John Wiley and Sons. USA.
8) Madigan M. T., Martinko T. M. and Parker J. 2000. Brock Biology of Microorganisms, 9thEd, Prentice Hall international, Inc. USA.
9) Moore T. C. 1989. Biochemistry and Physiology of Plant Hormones. Springer- Verlag, New York, USA.
10) Nelson D. L. and Cox M. M. 2008. Leininger: Principles of Biochemistry 5th Ed., W. H. Freeman and Company, New York.
11) Plummer D. T. 1988. An Introduction to Practical Biochemistry; Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
12) tryer L., Tymoczko L. and J and Berg J. M. 2006. Biochemistry, 6th Ed., W. H. Freeman and Company, New York.
13) Taiz L. and Zeiger E. 2003. Plant Physiology. Sinauer Associates, Inc., Publishers, Massachusetts. USA.
14) Voet D., Voet J. G. and Pratt C. W. 2006. Fundamentals of Biochemistry, 2nd Ed, John Wiley and Sons Inc.
15) Wilson K. and Walker J. 1994. Practical Biochemistry: Principles and Techniques. Cambridge University Press, Cambridge, UK.
16) Wilson K. and Goulding K. H. (Eds), 1996. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, U. K.

IV SEMESTER: SOFT CORE THEORY- SCT- 404
METHODS IN BIOLOGY

Credits-04 **Theory-64 Hrs**

Learning Objectives: *The learning objectives in methods in biology include understanding the principles and techniques used to identify and analyze bioactive compounds using different biochemical methods. Students learn how to perform qualitative and quantitative analysis using different instruments. Students will learn key biophysical techniques such as spectroscopy, chromatography, and electrophoresis. The course also introduces computational tools for binding site prediction and data mining.*

Course Outcome: *The course outcome of methods in biology enables students to proficiently identify, extract, and analyze various phytochemicals present in plants. Learners develop the ability to apply standard laboratory techniques for the qualitative and quantitative evaluation of plant constituents. It prepares students for advanced studies in fields such as molecular biology, biotechnology, and microbiology, while also supporting future research and career development in plant and life sciences.*

Unit- 1: Spectroscopy: Principles of UV-Visible spectroscopy, chromophores and their interaction with UV-visible radiation and their utilization in structural, qualitative and quantitative analysis of drug molecules; Infrared Spectroscopy, Infrared radiation and its interaction with organic molecules, vibrational mode of bonds, instrumentation and applications, interpretation of IR spectra; FTIR and ATR, X-ray diffraction methods.

Unit-2: Nuclear Magnetic Resonance Spectroscopy: Magnetic properties of nuclei, field and precession, instrumentation and applications of NMR; Chromatographic Techniques- Principles and applications- types- column, paper, thin layer and gas chromatography, HPLC, HPTLC, size exclusion chromatography, Affinity chromatography, Mass spectrometry, MALDI-TOF.

Unit-3: Electrophoresis: Principle and application of PAGE, SDS PAGE, immunostaining, immuno-electrophoresis, Iso-electric focusing, 2D electrophoresis Centrifugation- Principles, techniques of preparative and analytical centrifugation. Ultracentrifuges, molecular weight determination, sedimentation analysis, RCF. Microscopy- principles and applications of electron microscope (SEM and TEM), CryoEM, Preparations of specimen for electron microscopy- freeze drying, freeze etching, fixing, staining; confocal, fluorescent, flow cytometry - principles and applications.

Unit-4: Molecular Biology Techniques: Principles of nucleic acid isolation. Plasmid isolation. Principles of nucleic acid separation. Restriction digestion and DNA ligation. Principles of transformations/transfection. Genomic/c-DNA libraries. Primer designing; Principles and applications of PCR; Blotting techniques; Hybridization techniques; Micro-array; Nucleic acid sequencing. Next Generation Sequencing.

Suggested Readings

1) Braithwaite, A. and Smith, F.J. 1996. Chromatographic Methods. 5th edn. Blackie Academic & Professional London.

2) Budzikiewicz, H., Djerassi, C. and Williams, D.H. 1968. Mass Spectrometry of Organic Compounds. Holden-Day, San Francisco, CA
3) Harborne, J.B. 1984. Phytochemical Methods. 2nd edn. Chapman and Hall, London.
4) Harborne J.B. (1973) Phytochemical methods a guide to modern techniques of plants analysis. Chapman and Hall, London Ltd.

IV SEMESTER: HARD CORE PRACTICAL HCP- 405
ECOLOGY, PHYTOGEOGRAPHY AND CONSERVATION BIOLOGY SEED SCIENCE AND TECHNOLOGY

Credits-04 **Total Practical Hrs-64+64**

ECOLOGY, PHYTOGEOGRAPHY AND CONSERVATION BIOLOGY

1) Study of local vegetation by quadrate method.
2) Water analysis for pollution studies (Bio-monitoring: TDS, Hardness, Chlorides, CO_2 COD, DO, BOD)
3) Rapid detection of bacteriological quality of water with special reference to feacal coliforms.
4) Morphology and anatomy of plants in relation to habitats - Xerophytes, Mesophytes, Hydrophytes.
5) *In situ* and *Ex situ* method of conservation.
6) Eminent phytogeographers of the world (photos).
7) Study of continental drift (through charts).
8) Application of Remote Sensing, GIS and GPS in Forestry and Wild life management.
9) Biogeography of the world – Oceans, deserts, islands, mountains.
10) Biogeography of India –rivers, mountains, islands.
11) Floristic regions of world – India and Karnataka.
12) Study of endemic plants of India.
13) -16) Origin, acclimatization and distribution of Coffee, Cardamom, Sugarcane, Cashew, Ragi, Maize, Wheat, Rice and Cotton.

SEED SCIENCE AND TECHNOLOGY

1) Determination of physical purity of seed samples.
2) Determination of density or weight per thousand seeds.
3) Determination of seed Heterogeneity.
4) Visual examination of dry seeds for disease symptoms.
5) Determination of moisture content by hot air oven method.
6) Seed viability test- TTC method.
7) Determination of seed germination by TP/BP/Sand method.
8) Evaluation of seedlings vigour by BP/Sand methods.
9) Seed vigour evaluation by (a) conductivity test (b) Hiltner's test (c) Performance test (d)
10) Accelerated ageing test (e) Cold test.
11) Examination of suspensions obtained from washings of seed.
12) Infection sites studied by planting seed components.
13) Detection of seed-borne fungi and their characters of five seed borne pathogens.
14-16) Visit to seed industries/seed companies/ seed research stations.

IV SEMESTER: SOFT CORE PRACTICAL SCP- 406*
METHODS IN BIOLOGY

Credits-04 **Total Practical Hrs-64+64**

METHODS IN BIOLOGY

1) Calibration of bio-analytical instruments.
2) Principles and instrumentation and applications of imaging techniques.
3) Understanding TEM and SEM and imaging system, photography.
4) Understanding the principles of different centrifugation techniques,
5) Understanding the separation of fatty acids/lipids by TLC/HPTLC.
6) Separation of amino acids by thin layer chromatography (TLC).
7) Separation of Amino acids by paper chromatography.
8) Separation and purification of proteins through column chromatography
9) Isolation of antimicrobial compounds and testing antimicrobial principles.
10) Estimation of Antioxidant activity by DPP assay
11) Separation of proteins by PAGE and SDS- PAGE.
12) Separation of RNA by 2D PAGE and Silver nitrate staining
13) Understanding isoelectric focussing.
14) Isolation of small RNAs for epigenetic studies and their separation.
15) Understanding radioisotope labelling and testing.
16) Understanding the principles of IR/NMR for the characterization of chemical molecules.

(Above practical imparts strong biochemical and molecular biology skills and each practical need double the duration of the 3hrs. Hence 64+64 hrs given for HCP-406 to complete the projects)

FOURTH- SEMESTER: SOFT CORE PROJECT WORK: SCPW-407
PROJECT WORK

A student shall undertake a * Project Work (SCPW-7) of 8 credits in the Department or in any other University or Research Institute under the guidance of a Research Supervisor. The student shall submit a Project Report duly signed by him/her and the Research Supervisor for evaluation during viva-voce examination. **If the Project Work (SCPW-7) is offered, the student need not study one soft core (SCT 404) and one soft core practical (SCP 406) courses of 8 credits.

Sd/-
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(Sr. Professor & Dean, Faculty of Science and Technology, University of Mysore)
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